Summary

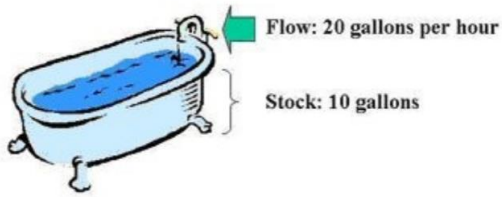
-Econometrics & Integration: Multinationals & Economic Development –

Lecture 0

What is the difference between FDI and MNEs?
MNE = Firms that own a significant equity share (typically 50 or more) of another company (henceforth subsidiary or affiliate) operating in a foreign country.
FDI = A form of cross-border investment with the objective of establishing a lasting interest that a resident enterprise based in one country might have in an enterprise operating in another country.
The difference is in ownership. In MNE you are the full owner, in the case of FDI not necessary.
When you see the data of FDI, it is 10 percent or more ownership. There is continuity in investment, it is a long term investment. With 10 percent or more you have influence in the company and have voting rights. It is important that the investor can have an influence on the managerial decisions in FDI.

What is lasting interest?
According to (OECD), ownership of 10% of the voting power by the foreign investor is an evidence of such a relationship.

What is the difference between stocks and flows?
Flow is over a time period, for example one year. How much it has changed or how much came into the company.
Stock is the accumulated value of what already came in. The accumulation of flows.



What is the difference between greenfield and M&A?
Greenfield investment is when you start a whole new company.
M&A is when you merge two existing companies or acquire an existing company.

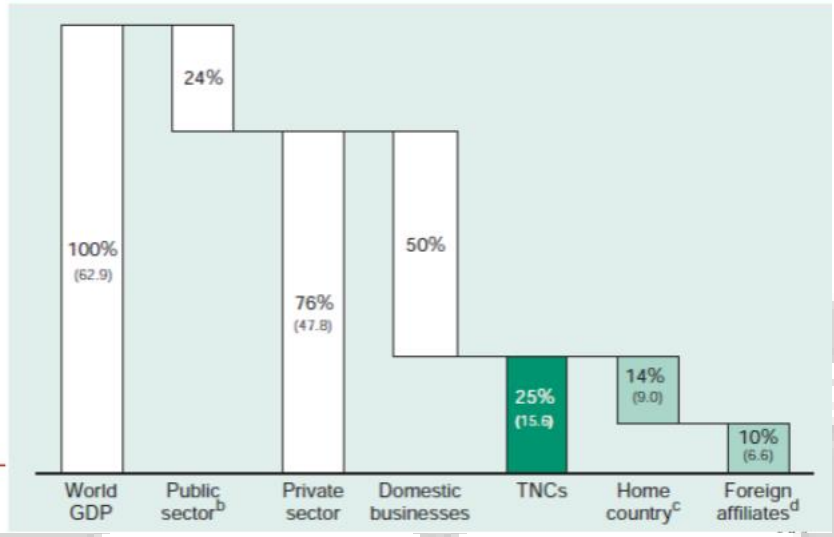
What is the difference between horizontal and vertical FDI?
Vertical FDI (forward and backward). It is about the value chain and the position of it. Which part you acquire. Example is Toyota that can buy a rubber company. Doing a part of your value chain in a different country. It can be an existing part of your value chain, relocating to another country. Backward and forward relates to where in your value chain it takes place.
Horizontal FDI is replicating an activity in another country.
Value chain: 1 → 2 → 3

- Moving 1 to abroad: backward vertical FDI
- Moving 3 to abroad: forward vertical FDI
- Moving 2 to abroad: both backward and forward.
- Replicating 1 to abroad: horizontal FDI (you also have it in your home country)

FDI flow is highly volatile. The trend is stronger/higher growth than income and trade.
If the economy is growing worldwide, you see a lot of investment at home but also abroad. Because of the lumpy nature of investment the FDI flow is very volatile. One year you invest a lot abroad, another year it is zero. The graph is about flows, but sometimes you can prefer stock. That one is less volatile and is better for your data analysis.

How important are MNEs in global economy?

Figure I.22. TNCs account for one-quarter of world GDP, 2010
(Per cent and trillions of dollars[a])



UNCTAD: WIR 2011

According to the data, greenfield investment is more important than M&A.

Lecture 1

Trade is good for nations as a whole.
→ By comparative advantage, both nations would gain. One country does what it's best in and the other does the same, then they start trading and gain from them. On the whole, a nation benefits and can maximize the allocation of goods. Trade would be not beneficial for some examples of external economies of scale and path dependency. The Swiss watches example. This is the only exception and still hazardous.

Trade helps the low-skilled in poor countries.
→ If a (poor) country is abundant in low-skilled labour, they will export those goods. Hence, low-skilled labour will gain from trade. The rest of the world wants the low-skilled to produce for them, but for the high skilled (in the poor country) it is not helpful. They have to compete with the high-skilled in the rest of the world. H-O model and income distribution.

Trade based on economies of scale leads to more choice for consumers and lower prices.
→ Monopolistic competition. Prices go down because of trade. Krugman model.
(External economies of scale is perfect competition.)

FDI and outsourcing are essentially the same thing.
→ FDI is a lasting investment. In outsourcing you can buy goods from another company. Are you in control of the company that produces the goods for you, or do you have a contract with a different country and you are just buying the goods from them? It are two different ways of getting things done abroad, do it yourself or get it done. FDI it is under your control, with outsourcing you buy things in a market contract/transaction. Your investment and stay in control, or a market contract and using an existing company.

Offshoring is engaging in foreign activities by means of FDI.
→ Offshoring more general is an activity taking place outside your country and it could be done by a FDI, but it could also be done by international outsourcing. It's the umbrella term.

Comparative advantage

- Trade is beneficial even when you're better in producing all goods → concept of comparative advantage.
- Both countries gain from trade, but division of gains in favour of smaller countries. (Ricardian model)

Trade and income distribution effects

- Both in the short-run (specific factors model) and in the long-run (HO-model) there are clear income distribution effects.
- The gains from trade allow compensating the losers without making the winners worse off. → economically it does not make sense to limit trade.

The winners win more than the losers lose, so the country gains as a whole.

Economies of scale and trade

- Trade may also be beneficial if no cost differences at all (if countries are the same). → economies of scale as reason for intra-industry trade. And bigger choice of products.
- Trade lowers costs of production and prices, increases choice of varieties, while there are no income distribution effects:
    - *Inter*-industry trade higher the more countries differ
    - *Intra*-industry trade higher the more similar countries are
- Including heterogeneity of firms leads to an additional source of welfare gains: improved industry performance. (Internal economies of scale)
- Path dependencies when external economies of scale: could protectionism make lagging countries and/or world better off? (Hazardous argument, but at least one theory that says it could be useful to at least temporarily stall the trade.)

Stylized facts of FDI and MNEs

- FDI has been growing faster than world trade and world GDP.
- FDI used to be mainly to and from advanced countries, but the importance of developing countries has clearly increased.
- MNEs are important vehicles for FDI and trade. (Vertical FDI means that you produce something abroad that you have to ship abroad. Horizontal is a substitute where you produce It locally.)

+

- FDI concentrates in skill- and technology-intensive industries.
- FDI consists of greenfield and brownfield investments.
- The services sector accounts for a major share of FDI.

Horizontal FDI is substituting for trade, vertical FDI then you need to ship it over the world and trade.

Why become a MNE?

Costs and benefits of geographical dispersion?
→ Labour costs could be simply cheaper in the other country.

- Cost: economies of scale foregone (particularly with horizontal FDI → Replicating something in another country. Twice the fixed costs, so less cost advantages there).

- Lower EoS when duplicating activities (twice the fixed costs).
- Relevant distinction between plant level EoS vs. firm level EoS.
  →Especially firm plant level, you have twice the FC. On firm level it is the brand, you don't have to duplicate that. You don't have to restart a brand. In the firm level it makes it easier to expand.

- Cost: economies of integration foregone (transportation costs, export costs, etc.)
  → Vertical FDI. Splitting up the value chain. Might become to costly, even if there are some benefits.
  - Because of geographically slicing up the value chain
  - Costly because of increased trade costs (in a broad sense)
- Benefits:
  - Improved market access.
  - Improved competitiveness abroad. (If you are at the market you don't have transportation costs, so you don't have to export.)
  - More favourable factor costs.

Factors influencing FDI theory

Table 2.3. Determinants of FDI: theoretical predictions.

Determinants	Prediction by type of investment: Horizontal	Vertical
Determinants relate to types of firms or industries		
Firm-level economies of scale	+	+
Plant-level economies of scale	–	?
Product-specific trade costs	+	–
Costs to disintegrate stages of production	–	–
Difference in factor intensity between stages of production	?	+
Determinants relate to types of countries		
Trade costs (distance, trade barriers, etc.)	+	–
Market size	+	?
Factor cost differentials	?	+

Internalization issues regarding MNEs? (Keeping things internal. You stay in control, keeping things internal. There could be a reason that you want to do that.)

- Internalize because it is more profitable to conduct transactions and production within a single organization than in separate organizations

You can make big mistakes in cultural differences, so it would be beneficial to be in the country. There could be a reason that you really want to be in control and don't want to outsource. It could be costly, you have knowledge that you don't want to tell. You could also be afraid of losing your comparative advantage.

Table 8.2 Location and organization decisions

		Location decision	
		Home	Foreign
Organization decision	In-sourcing	Domestic in-sourcing	FDI
	Outsourcing	Domestic outsourcing	Foreign outsourcing (offshoring)

Note: If the firm relocates to the foreign market, we could have foreign in-sourcing.

- Transfer of knowledge or technology may be easier and less risky within a single organization than through a market transaction between separate organizations.
  → You could also be afraid to lose your comparative advantage of your knowledge when you let someone else do it abroad. losing your business if others have the knowledge, so that could be a reason to stay in control within the boundaries of your company.
  - Weak or non-existent patent or property rights. (It is relatively easy in that country to just copy the knowledge or thing.)
  - Knowledge may not be easily packaged and sold
- The issues involved may be different for horizontal FDI and vertical FDI, see Table 2.4

Modelling MNEs: A general equilibrium approach
Markusen-Venables model of horizontal (FDI) MNEs

- 2 countries, 2 production factors, 2 sectors
- Perfect competition and CRS for food sector, uses K & L
- Imperfect competition and IRS for manufacturing sector, uses L only (here international competition takes place)
- Both homogenous goods: Cournot competition (where they compete in quantities with each other) in manufacturing (Betrand competition, competing in prices, does not make sense for homogenous goods.)
- Cobb-Douglas preferences.
- Free entry and exit until profits are zero (no government interference, no externalities, etc.)
- Factor market clearing and goods market clearing. (No obstructions, only demand and supply)

→ Will they engage in trade or in FDI?

Characterization production of manufacturing:

- *c* – The (constant) marginal production costs in terms of labor
- *t* – The amount of labor needed to transport one unit of manufactures from Austria to Bolivia, or vice versa.
- F – The firm level fixed costs in terms of labor. (Each firm always has a FC at the plant firm level.)
- *G* – The plant level fixed costs in terms of labor. (If produce locally, two plants, if trading, one plant.)

Types of firms possible:

- National firms with HQs in A or B (means that if it is located in A, it only produces there).
- Multinational firms with HQs in A or B (where to put your firm level fixed costs (HQs) and they need a plant in both countries.)

Cost functions per type of internationalisation

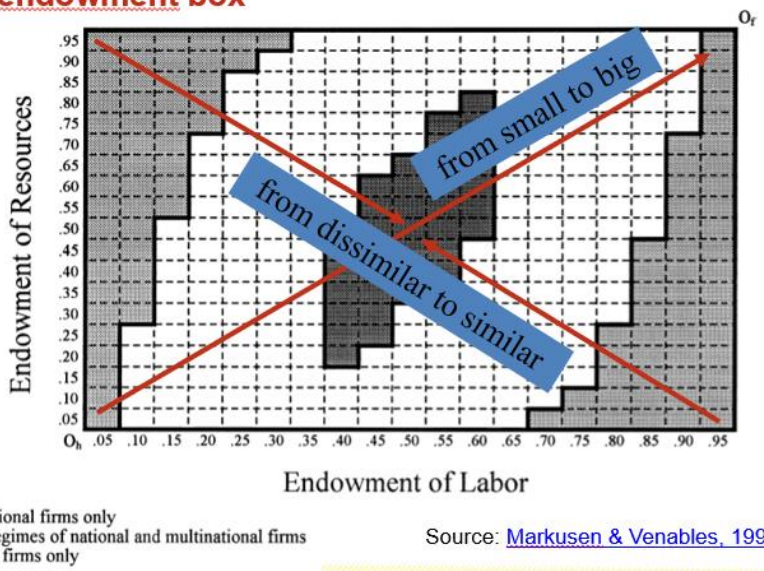
national firm: $(F+G)w_A + cw_A M_{AA}^n + (c+t)w_A M_{AB}^n$

multinational firm: $(F+G)w_A + Gw_B + cw_A M_{AA}^m + cw_B M_{AB}^B$

Everything the national firm does is in country A, so only wages in country A.
The MNE has to pay the labour for country B in B, but also wages in A.
The MNE has a plant in A and also in B, where the national firm only has a plant in A. It's horizontal FDI, so replicating, that's why you need two plants. HQs are in A for both countries.
Direct benefit of a MNE is you don't have transportation costs (the national firm does have them), disadvantage is that you have twice the fixed costs for plant level.

There are many equilibria possible, that's why you need a model to see what kind of equilibria and firms we are expecting.

World endowment box



Source: Markusen & Venables, 1998

(This is also in the reader. They start explaining what happens there.)
The two axes are for labour and resources and it shows the division over the two countries.
A point in the world endowment box gives the division of resources between two countries.
Left on the bottom: home is small and foreign is big. So foreign has the biggest market. If home exports they have a lot of transportation costs. In this corner it will be a national firm from foreign, they have the big market and they export to a tiny market, home. The fixed costs of becoming a MNE will be higher than the transportation costs you save. The national firms will never be from home.
Think about it in terms of trade-off.
The basis trade-off is between the transportation costs saved and the costs of the extra plant level.

From left bottom to middle: n_f, $n_f m_h$, $n_f m_f m_h$, $n_f m_f$, m_f, $m_f m_h$
Explanation?

- Wages remain the same.
- Scale economies and size of markets.
- Transportation costs savings and extra plant cost.

You will move your HQs where the wages are lowest, because that's a cost you will always have. But if it's a small country, the labour force is lower and your plant will have a high weight on the labour force, so wages increase a lot. Bigger impact on wages, so that's the strange pattern of emerging.

From left up to middle: n_f, $n_f m_f$, m_f, $m_f m_h$. Explanation in WG.

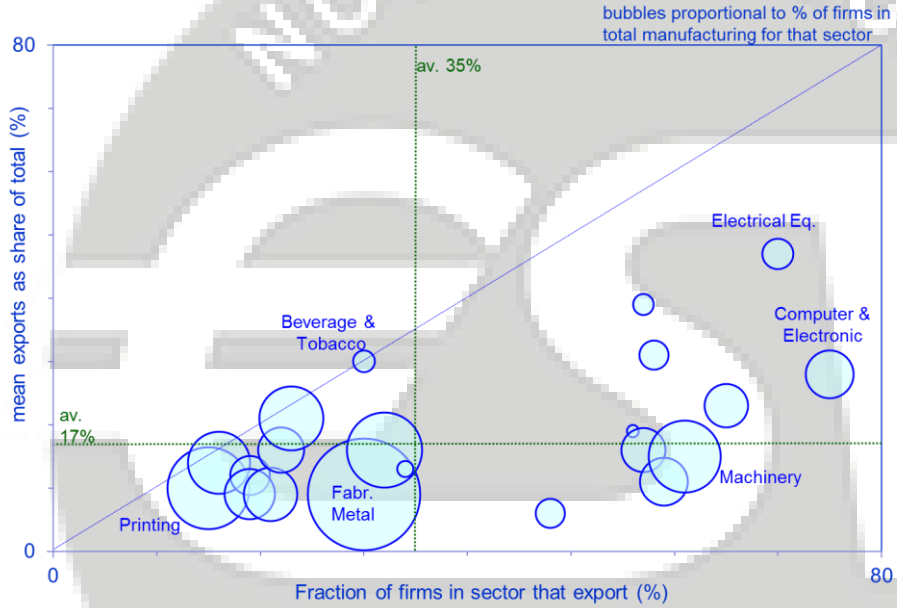
The importance of firm heterogeneity for trade and FDI

Firm heterogeneity

→ We are now entering the world of monopolistic competition where you have different varieties of a particular product. What if firms are not identical? Differ in many aspects, also in export orientation.

- Firms differ in many aspects, also in export orientation. (Firms are not identical.)
- Firms exporting is also less prevalent than often thought.
- Trade is highly concentrated: firms that export are few, very large multi-product firms that ship to many countries.
- We employ the Melitz (2003) model of international trade to explain that the most productive firms will export and/or engage in FDI.
- Also shows a new channel through which market integration could be beneficial: an effect on industry performance.

Firms exporting are relatively rare (this is data of the US) (Van Marrewijk, fig. 13.3)



The fraction of firms in the sector that export. The average of all sectors together is 35%, but it varies a lot across sectors. In technological/advances sectors, where the USA has a comparative advantage in, it will be higher.

Not many firms export and the firms that do don't export that much. Even firms that do export sell most to their domestic market This is what the average of 17% says. Only for beverages and tobacco the number of firms that export is proportional to how much these firms export as a percentage of total sales. The other sectors are not on the diagonal.

Most firms export only one product to one other country.

Trade exporting is rare, but it is also highly concentrated. 11.9% of firms exporting 5+ products to 5+ countries account for 92.2% of the total export of the USA.

Trade exporting is rare, but it's also highly concentrated.

Trade is highly concentrated

- Trade is concentrated.
  - In 2000, top 1% US trading firms by value accounted for >80% of value total trade (top 10% for 95 %)
- Trade is scarcer than thought.

- Most firms export to one or two countries only (>75%); only few firms export to 5+ countries (14%)
- The 5+ country exporters account for 93% of export value and 70% of employment.

Firms that export are few, very large multi-product firms that ship to many countries.
To explain this, we need the Melitz model. We see that firms differ by productivity. There is a large difference between exporting firms and non-exporting firms. They looked at this as well for Dutch firms. Value added per worker is much higher for exporting firms than for domestic oriented firms.

Causality?

- Do high productivity firms self-select into exporting firms or are they more productive because they export?
- Bernard et al. (2007):
  - Nearly all studies show that high productivity precedes exporting.
  - Most studies also find no evidence for increased productivity growth after beginning to export.
  - However, many studies show employment and output growth for exporters to be substantially faster than for non-exporters.

It could be that they are more productive, but it could also be that they earn more profits, so they can invest more and then become productive.
You need to be good at something first, to overcome the liability of foreignness. No reverse causality.

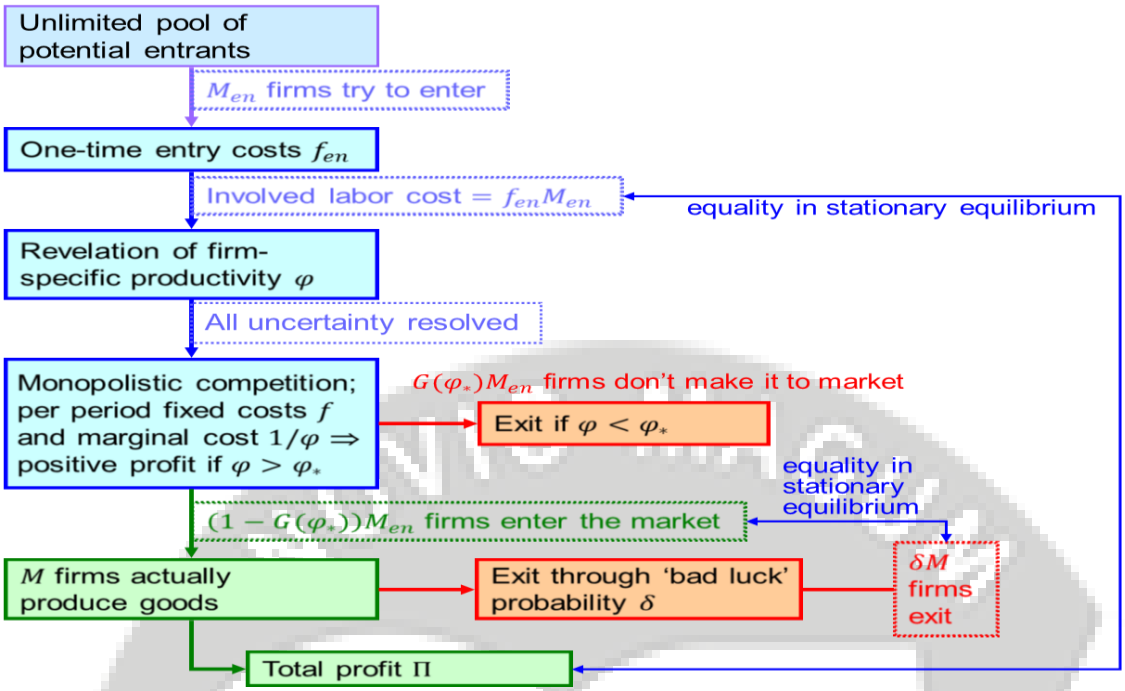
The Melitz-model

- Is a monopolistic competition model of intra-industry trade *plus* heterogeneous firms and firms facing uncertainty when entering the market.
- Monopolistic competition?
  - Economies of scale at the firms level: $l_i = f + mq_i$
  - All firms face identical (in mind of consumers) iso-elastic demand $c_j = p_j^{-\varepsilon}[P^{\varepsilon-1}I]$ with $\varepsilon > 1$ the elasticity of demand → price is a mark-up over marginal cost: $p = \frac{\varepsilon}{\varepsilon-1}mW$
  - Free entry and exit of firms until 'zero' profits: $pq_j = [f + mq_i]W$ → $q_j = f(\varepsilon - 1)/m$ for all firms

If p goes up, it has a negative power. The law of demand. Positively related to other things, if all other firms have a higher price, my demand will be bigger. Income goes up, demand for a product goes up. Shift of demand function.
Price is a markup of marginal costs (if you have a price function like this).

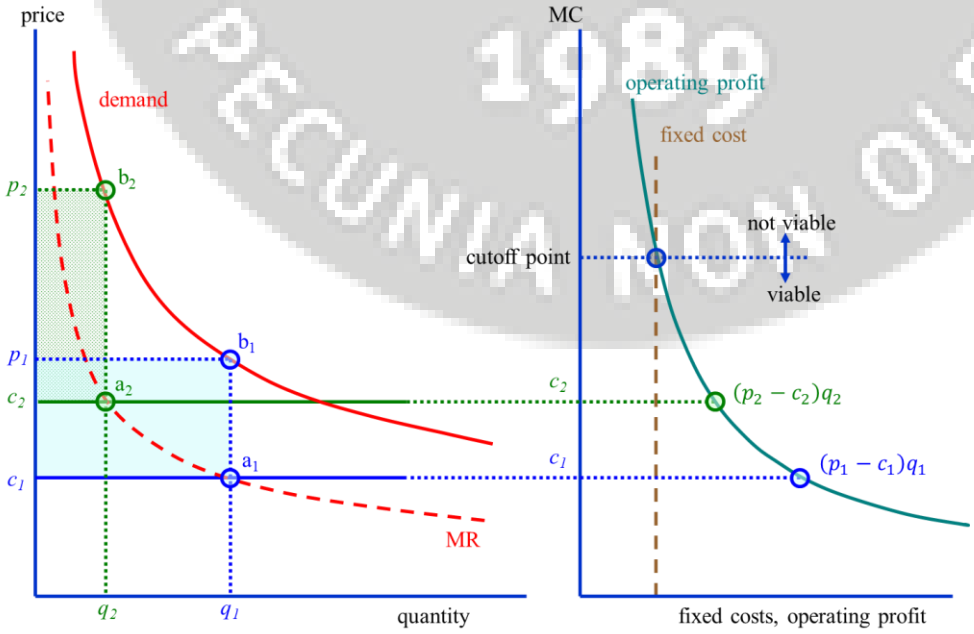
Required changes for Melitz model:

- Economies of scale at the firm level: $l_i = f + mq_i/\boldsymbol{\varphi}$
  - The more productive you are, the bigger your phi is.
- Free entry and exit of firms until 'zero' **expected** profits → comparison of net present value of future profits to sunk entry costs.
  - Free entry and exit is before you know your productivity. It's clouded in uncertainty. Till expected profit is zero.
  - Fixed entry costs are sunk costs. You don't take them into consideration when you leave or not.



Unlimited pool of potential entrants. They have a one-time entry costs and then they start knowing what their productivity is. They decide if they want to stay or get out of this market. You get out when you don't have positive operational profits anymore, otherwise you stay. It could be less than expected, but a profit is a profit. Your fixed entry costs are sunk costs, so you can't get them back. You don't take them intro account, you look at the costs from this point onwards and if that's positive you continue. There is monopolistic competition, firms produce goods and have a chance of exit because of bad luck. Even the firms that remain and profits are positive, can have bad luck and have to leave the sector (exogenous change, e.g. earth quake or lightning struck or whatever). Some firms exit and other firms will enter again. That is the basic structure of the model.
The graph that belongs to that is below:

Firms heterogeneity, prices and profits (Van Marrewijk, 2017)

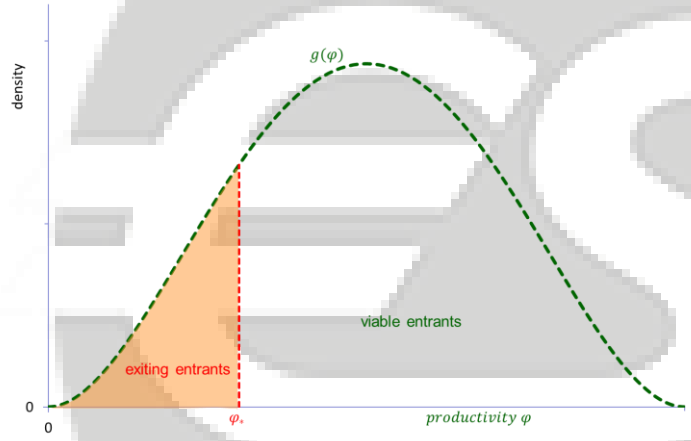


Demand and marginal revenue are the same for all firms. Marginal costs are different, a lower MC indicates a higher productivity. The operating profit declines with the MC. If they are lower, operating profit is higher.
Operating profit = what you earn – MC
You need that to get the fixed costs back.
This defines a level of productivity beyond which you will stay in the market. If FC is higher than the operating profit, you should discontinue in the market.

Entry, exit and equilibrium

- Firms do not know their productivity until they have entered.
  - They exit immediately if productivity level is too low to generate positive operating profits.
  - The level of sustainable entry φ_* is endogenously determined in the model.

Firm entry problem.
You know you have a bunch of firms that can be very productive or not productive. It is an ex ante problem. Some firms find out they are less productive than expected and they will exit.



Entry, exit and equilibrium

- Profitable firms also face an exogenous risk of $\delta > 0$ to exit → NPV of profits is π_φ/δ
- Decision to enter the market is based on comparison expected NPV profits and entry costs $f_{en} > 0$:
  - NPV of profits is $\pi_\varphi/\delta = \frac{[B\varphi^{\varepsilon-1}-f]}{\delta}$ for $\varphi > \varphi_*$
  - Free entry condition : $\int_{\varphi_*}^{\infty}\left[\frac{(B\varphi^{\varepsilon-1}-f)}{\delta}\right] g(\varphi)d\varphi = f_{en}$
  - This is calculating your expected net present value. That should be equal to your entry costs. You don't know your productivity yet, so you have to calculate the NPV for each one. Related to all your NPV's, your expected profit should be equal to the fixed entry costs, otherwise you won't enter. This is calculating your expected NPV in times of uncertainty.

- Using $\pi_{\varphi*} = B\varphi_*^{\varepsilon-1} - f = 0$ in the free entry condition gives φ_*:
  $\int_{\varphi_*}^{\infty}(\varphi^{\varepsilon-1}\varphi_*^{1-\varepsilon})g(\varphi)d\varphi \equiv h(\varphi_*) = \delta f_{en}/f$

What if trade?

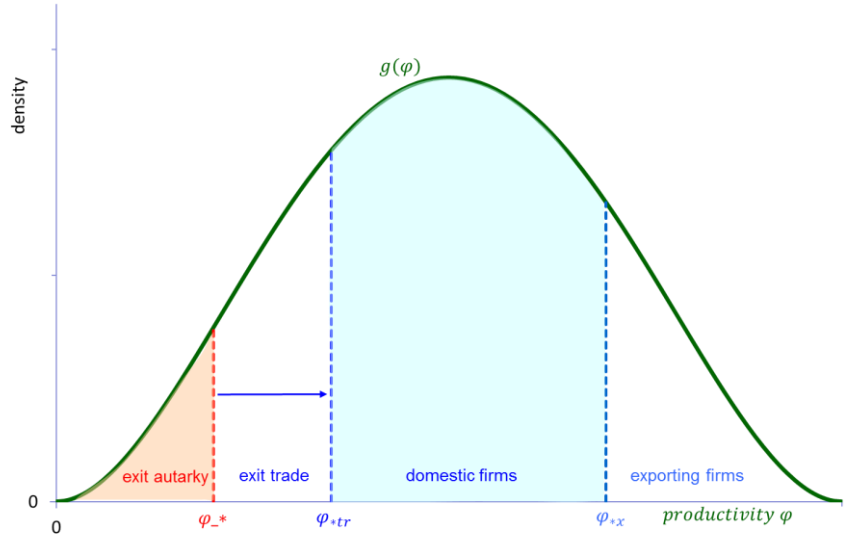
→ We have a basic model. The next step is what happens if you have trade. Some things change, because you also produce for the foreign market. This is not in uncertainty, because you already know you could make a profit in the market.

- Modelled as an additional entry decision, involving an extra fixed cost of reaching foreign markets.
- Also involves iceberg-type of transportation cost when exporting.
  - Price domestic market: $p_\varphi = \frac{\varepsilon}{\varepsilon-1}\frac{1}{\varphi}$; price foreign market: τp_φ
- Firm will export if extra revenue outweighs extra fixed costs:

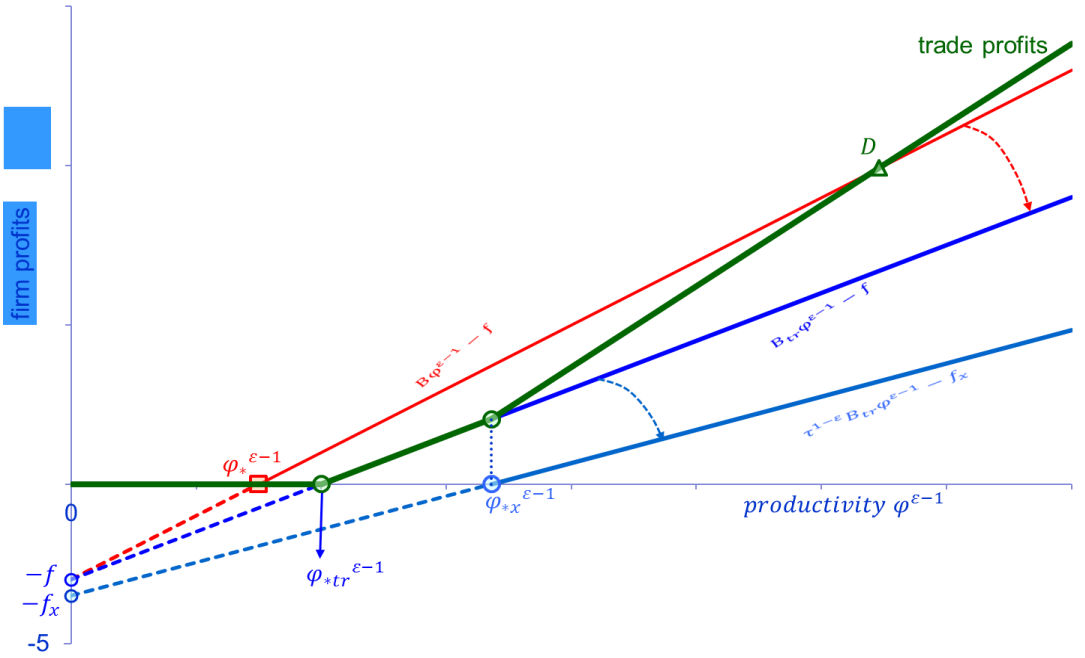
$$\tau^{1-\varepsilon} B_{tr} \varphi^{\varepsilon-1} > f_x$$

- Cut-off productivity for exporting $\varphi_{*x} > \varphi_*$ assumed.

Trade and distribution of firms



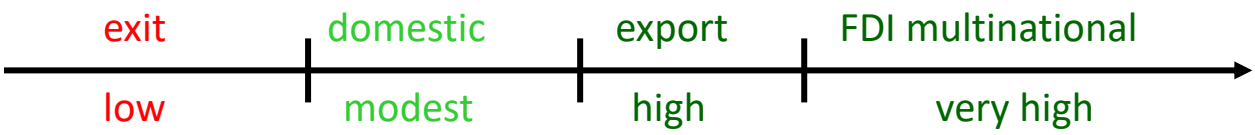
International trade viability and profits



What if FDI?

- When engaging in FDI, the fixed costs are assumed to be higher, but the transportation costs are saved.

Mode of entry



In the end, you will see that the model predicts that the least productive firms will not be in the market at all, some will produce only in the national market and the very productive firms will become MNEs.

Lecture 2

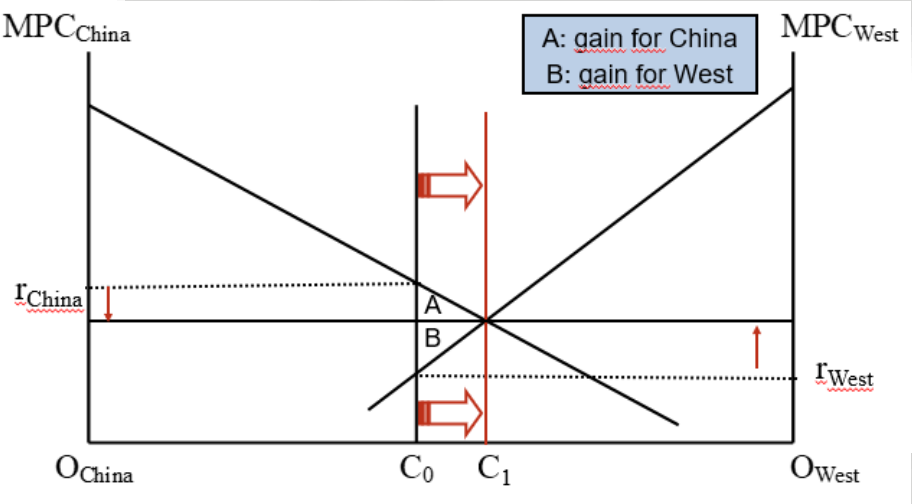
Impact on home and host countries.

Impact of trade and FDI in standard trade models.

Effects of trade and investment

- Trade is beneficial for both countries due to increased efficiency in allocation of resources internationally. (More allocation of resources)
  - Increases world welfare and output.
  - Both nations gain, but also redistribution of income within both nations.
- These effects would be similar if we would have capital mobility rather than trade.

Resource allocation effects of VFDI



→ Division of capital in the world.

In China, if you have more the marginal product will decline. Downward sloping, diminishing marginal returns. All the other resources don't change. Likewise for the West.

Initially, reward to capital in China is bigger than in the West. The West is more capital abundant, that's what we believe, so capital is relatively cheaper. In other words, you can earn more money if you invest in China.

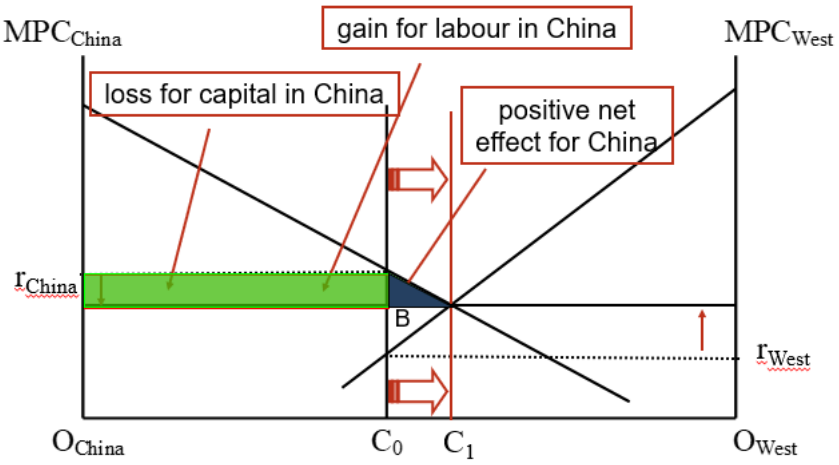
→ What happens if we open up our borders?

Capital moves to China. Up till the point where the rates of returns in both countries are the same. We ignore all other sorts of transaction costs.

→ How do we see that China gains from this? Allocation effects.

After the capital movement, production in China has gone up. Capital in the West was less productive compared to China, so loss in production for the West. The difference is the triangle. Both countries gain from it. Loss in production, but the capital owners still have money and that goes to the West.

Income distribution effects (for China)



The capital owners in China lose from it. More capital owners come in so more competition. But labour gains by the green area. The rest of the production must go the other people, so they gain. The gains for the abundant factor in China are greater than the losses for the scarce factor.
If you would do the same for the West, capital owners gain more than labour will lose.
This are the standard resource allocation effects. We now open up the borders not for trade but for capital movement. The effect is similar to H-O, better allocation of resources. But there are income distribution effects. Same kind of framework.

The Feenstra-Taylor Approach to offshoring
The Feenstra-Taylor Approach:

- Particular activities are 'offshored' and the L-intensity may be in the eyes of the beholder: a low-skilled intensive activity here may be a high-skilled activity there.
- Note their interpretation of 'offshoring': 'offshoring' is any (part of) a firm's operations that is done abroad, irrespective of ownership.

→ Particular values in the value chain could be offshored. What could be considered labour intensive here can be considered capital intensive there, compared to all other activities.
→ Offshoring is umbrella term for FDI and outsourcing. They notice it, but they don't care about ownership. You can do something abroad, but they ignore the issue if it is a MNE or outsourcing. We just assume things are being relocated to other countries.

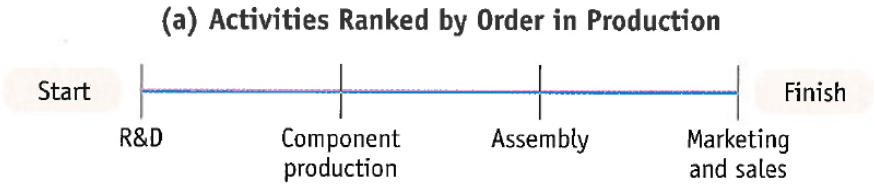
Elements of their modelling set-up
→ They basically say that foreign is less productive in everything. The wages there will be lower both for low-skilled and high-skilled labour. But relative the wages of low-skilled are lower than for high-skilled. (When developing this, they probably had in mind Mexico and the USA.)

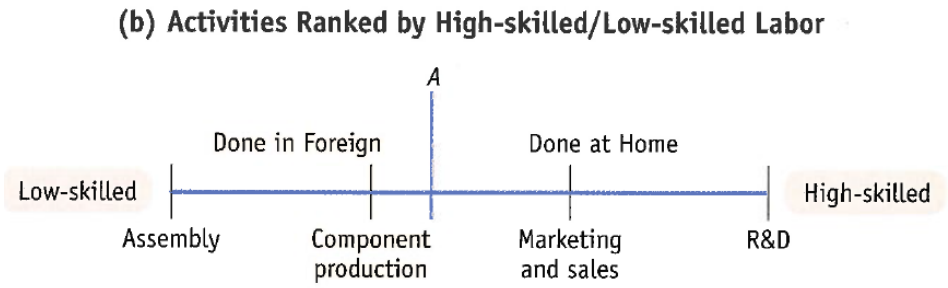
- Production activities are ranked according to skill-intensity.
- All wages are lower in Foreign than in Home and Foreign has relatively cheap low-skilled labour:

$$W_L^* < W_L \text{ and } W_H^* < W_H$$
$$W_L^*/W_H^* < W_L/W_H$$

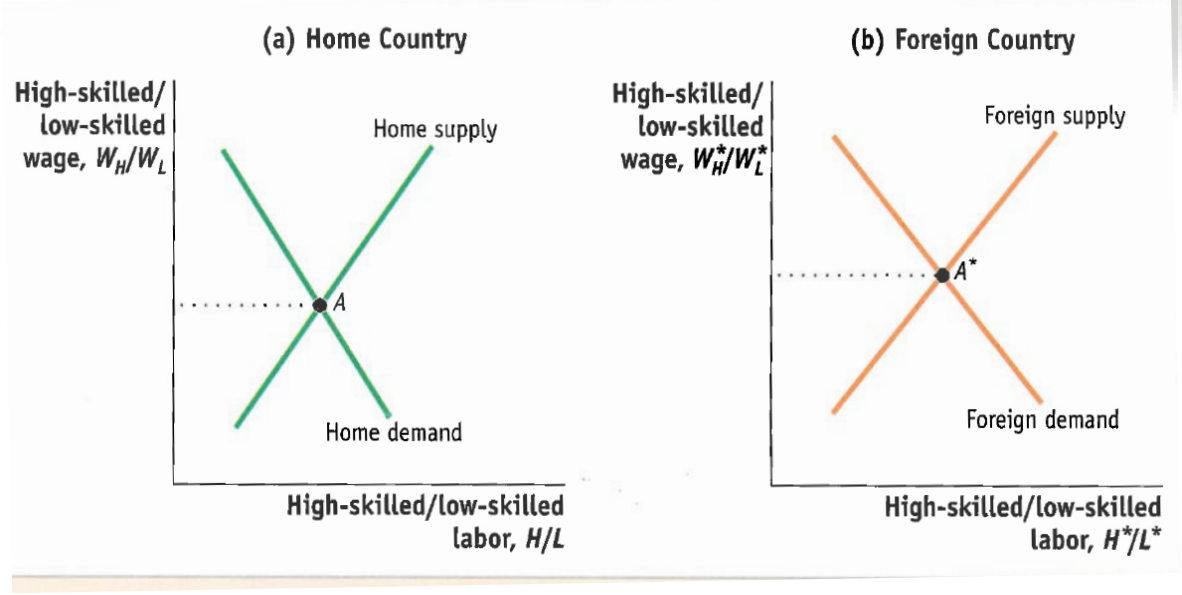
- Offshoring requires extra capital costs, transportation costs, trade barriers, etc. → "trade costs".
  → offshoring requires some extra capital costs. If you cross the border, this is costly to you. They call it trade costs, the costs of being in another country.
- Trade costs are uniform across activities → offshore those activities for which cost advantage exceeds trade costs.

- → Limited assumption, but to make their point it is useful. They can focus on relative skill intensities, that's why they assume it's all the same.



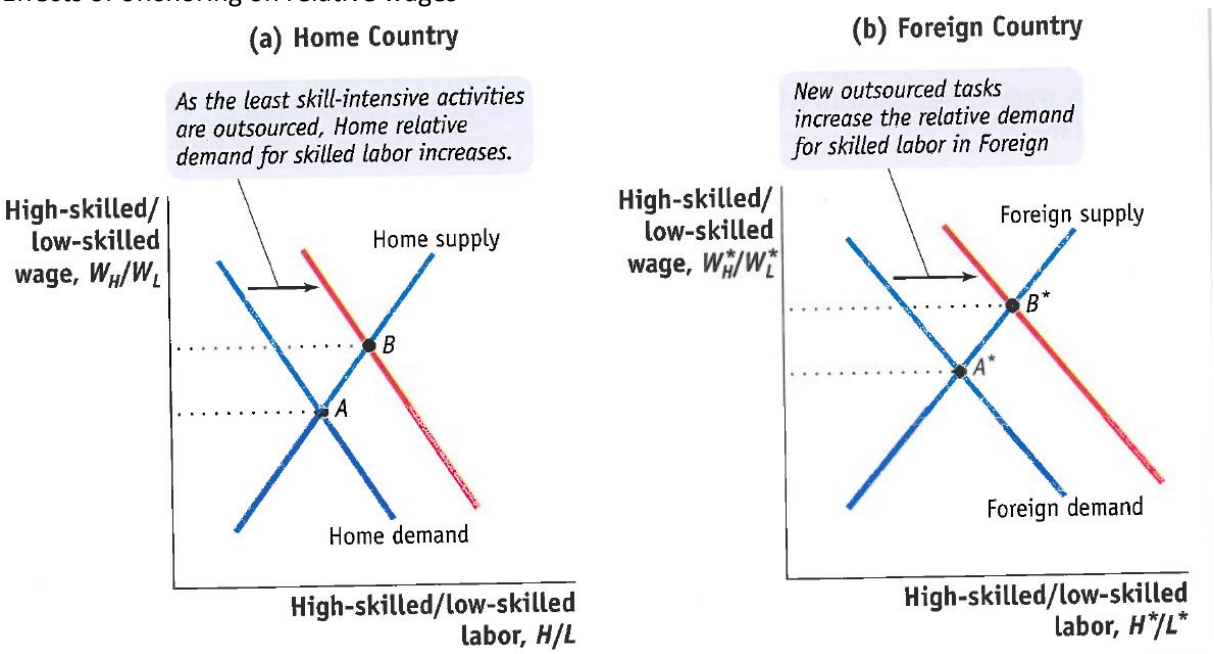


→ They re-rank them according to high-skilled and low-skilled intensity. Depending on the relative wages and if offshoring is possible, they will start offshoring the most low-skilled intensive activity (de activiteit die het meest low-skilled is). This is because foreign has the relative lower wages for low-skilled.
What will then happen with the relative wages? The key point is that the low-skilled and high-skilled intensity is in the eye of the beholder.



Looking at high-skilled and low-skilled labour and the supply and demand we get these graphs. The slopes of the curves are exactly the same in foreign.
Initial point A autarky equilibrium, no offshoring at all. The crossing in home is lower than in foreign. Foreign is a poor country, that's the idea. More low-skilled labour.

Effects of offshoring on relative wages



We are getting rid of our low-skilled activities, so you need less low-skilled labour. Their wages go down so relative high-skilled wages go up.
The low-skilled activities could be high-skilled activities there. That is what the case is. Also in foreign, the relative wages of the high-skilled go up.
At the moment they wrote this, the idea was new (and a bit contrary to HO). They could do this because they split up the production process and particular parts of the activities are moved.

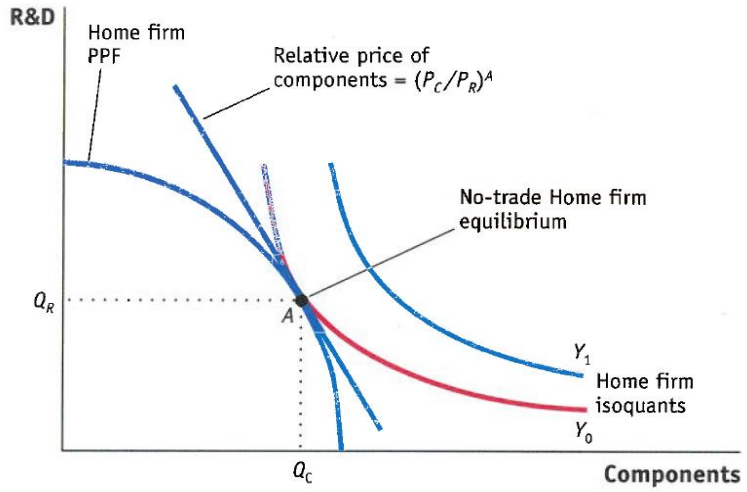
The Feenstra-Taylor Approach

- Do their theoretical predictions hold in reality?
- The WG next week requires you to look into this by means of:
  - What they discuss regarding the effects of offshoring on US and Mexican wages,;
  - How offshoring could be related to the issue of 'job polarization' in the US.

Welfare effects of offshoring

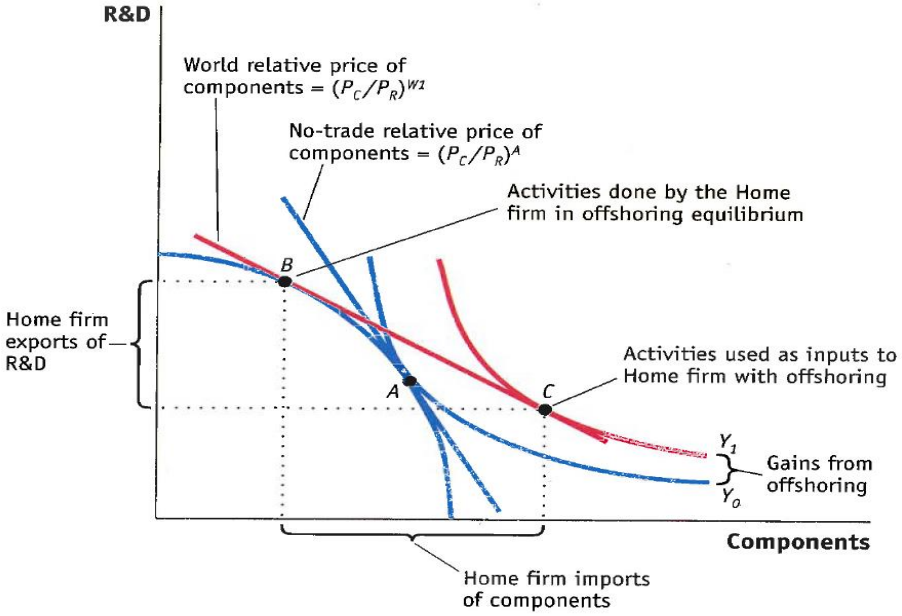
- Take the Feenstra-Taylor approach, but strip it down to only two intermediate activities in firm production (R&D and components)
- A firm can use its resources to produce different combinations of these intermediate activities → a firm's PPF
  → They have resources and have to choose if they want to produce components or R&D.
- A firm can use different combinations of the two intermediate activities to produce final output → isoquants
  → With the R&D and components you can combine them into a final product.

The simplified offshoring model



→ Isoquants indicate that if you want to produce this amount of final output, you need this amount of R&D and components. The PPF should match what we can produce ourselves, given our resources. The shared line is the relative price of components. This is the optimal amount to produce.
→ Offshoring helps us to reach a higher isoquant, just as if it were international trade at firm level.

Effects of trade in the simplified offshoring model



Initial point is at point A, but suppose now foreign components are now relatively cheap. This will mean that price of R&D component curve is flatter. You need less R&D resources per component, because components are now cheaper. Red line is the relative price, so point A is not the optimal point anymore. It will be more optimal to produce more R&D and selling parts of that to foreign in exchange for components. We can now reach a higher isoquant, benefiting from comparative advantages. Gains from offshoring. Same amount of resources of the firm, higher output levels.

Effects of FDI

- Feenstra-Taylor's offshoring model shows that offshoring is beneficial for the country as a whole, much like the standard Heckscher-Ohlin treatment of international trade.
  → The idea of the framework is identical to HO.
- The income distribution effects are however quite different:
  - HO: bad for L and good for H in Home, and vice versa in Foreign
  - FT: bad for L and good for H in Home *and* Foreign
  - Which model applies? → US – Mexico case (next week's WG)

  → F-T model says it is bad for low skilled anywhere and good for high skilled anywhere. This is different from the H-O model.

Product market effects of MNEs at home and abroad

Table 2.5. Summary of effects of MNEs in home and host countries.

Where do the effects arise?	Effects: Host	Effects: Home
Product markets		
	Productivity differences	Productivity differences
	Competition and market supply	Output levels
Factor markets		
	Employment and wages	Employment and wages
	Skills	Skills
	Volatility	Volatility
Spillovers		
	Transmission of technology	Technological sourcing
	Transmission of intangible assets	
	Pecuniary externalities	

Zooming in: Product market effects in host countries
→ What happens if a MNE enters a host economy?

- Assume CES-utility function (constant elasticity of substitution) for products in some industry in host economy (Country 1).
- 3 types of firms active on host market: local firms, foreign exporting firms, foreign MNEs.
- Firms within a group are all the same.

Then:

$$
\begin{cases}
G_1 = [n_1 p_1^{1-\sigma} + n_2 (p_2 \tau)^{1-\sigma} + m p_m^{1-\sigma}]^{1/(1-\sigma)} \\
E_1 = n_1 p_1 x_1 + n_2 p_2 \tau x_2 + m p_m x_m, \\
x_1 = p_1^{-\sigma} G_1^{\sigma-\eta} \bar{E}_1, \\
x_2 = (p_2 \tau)^{-\sigma} G_1^{\sigma-\eta} \bar{E}_1, \\
x_m = p_m^{-\sigma} G_1^{\sigma-\eta} \bar{E}_1.
\end{cases}
$$

→ Price index of CES utility function.
→ Sigma (= elasticity of substitution) is bigger than 1. Elasticity of substitution comes from the CES utility function and says that consumers get different varieties of all the goods. To what extend are the varieties a substitute for each other. To what extend is a Mercedes a substitute for a BMW?

→ You need G and E to come to the demand equations. E is total expenditure on these types of products. It is the number of local firms times the price times the output they sell per firm.
→ Number 1 firms. Demand for output of the firm is inversely related to its own price. Also related to the overall level in society.
→ The reason for the eta is that we have the industry, but that is not the whole story. There is also another industry and the products in this industry are also a kind of substitute for other products in the economy. In any case, elasticity is bigger than 1. General price level goes up so we sell more output. And positively related to the expense of cars in the economy. Standard feature of the CES utility function.
→ E bar signifies the total expenditure in the economy on this type of products. If in general people start buying more cars, we also have our share of the extra sales.
→ Difference with firms that are exporting to our country is that they carry transaction costs. When prices would be the same, you have a disadvantage of transportation costs.
→ MNEs have the same demand structure as a local firm. Prices and productivity could be different. MNEs could be more effective in competing with local firms.

- What are effects of MNEs?
  - Direct effect 1: entry of MNE → dm = 1 selling $p_m x_m$
    → What is there is simply one MNE firm entering?
  - Direct effect 2: foreign exporting firm becoming MNE either as a greenfield ($dn_2 = -dm$) or by M&A ($dn_1 = dn_2 = -dm$)
    → A foreign exporting firm becomes a MNE. As a greenfield or by M&A.
  - Indirect effect through entry/exit local firms → dn_1
    → If these firms enter, it might be that they become more competitive compared to national firms and some national firms have to exit.
- All effects mediated through price index function:
  → We know if there is a change in the number of firms involved, everything else the same, there is an effect in the price index.

$$\frac{dG_1}{dm} = \frac{G_1^{\sigma}}{1-\sigma}\left[p_1^{1-\sigma}\frac{dn_1}{dm} + (p_2\tau)^{1-\sigma}\frac{dn_2}{dm} + p_m^{1-\sigma}\right]$$
$$= \frac{G_1^{\eta}}{\bar{E}_1}\frac{p_m x_m}{1-\sigma}\left[\frac{p_1 x_1}{p_m x_m}\frac{dn_1}{dm} + \varphi\frac{dn_2}{dm} + 1\right],$$

(For direct effects)

$$\frac{dn_1}{dm} = (\varphi - 1)\frac{p_m x_m}{p_1 x_1} \leqslant 0.$$

(For indirect effect)

→ How does the price index in a country change if the number of MNEs change? Derivative. First the top formula, then the next one (for direct effects). Sigma is bigger than 1, so the term in front of the formula is a negative one. What the other term becomes depends on what we are looking at.
→ Phi is defined as the relative sales of a national firm exporting to the relative sales of a MNE. Assumed that it is smaller or equal to one. (Firms are essentially identical, so difference in sales is difference in prices. Firms exporting could have transportation costs, so higher prices. So their sales will be less than of MNEs.)
$p_2x_2 / p_mx_m \leq 1$
→ If we would have 2a (Greenfield), we would expect a positive (direct) effect. If M&A then two firms are disappearing, one firm comes back. Good news for consumers.

→ The indirect effect goes through the entry and exit of local firms. Until zero profit, in initial equilibrium. Also here, the zero profit level, because the effects take place through the price index. In the end, whatever happens, we want the zero profit level. We are looking for an effect that keeps the price level the same. Same profit, of zero, as before.

Zooming in: Output effects of FDI in home and host

- 2-stage production: components (c), assembly (a) (assembly is labour intensive).
  → We could split our value chain. These two are needed for final product.
- Both stages using capital and labour, under CRS.
  - Unit cost functions $c(w_i, r_i)$ and $a(w_i, r_i)$, i = country index
- Additive total cost function:
  → Total cost of producing a component in I, assemble it in J and sell it in K. I, J and K could be the same, then you have no transportation costs.

$$B_{ijk} = [c(w_i, r_i)\tau_{ij}^{c} + a(w_j, r_j)]\tau_{jk}^{a}$$

- 2 countries (i = 1, 2), $w_1 > w_2$; moving from 1 to 2 or other way around same trade costs.
- Country 1 has comparative advantage in overall production; assembly is labour intensive → if fragmentation occurs, it will take place in country 2.
  → Wages in country 2 are lower, so for assembly you pick the lower cost country.
  → A lot depends on the transportation costs, if they are too high for shipping an assembly products you will do that in both countries.

When to split up production?

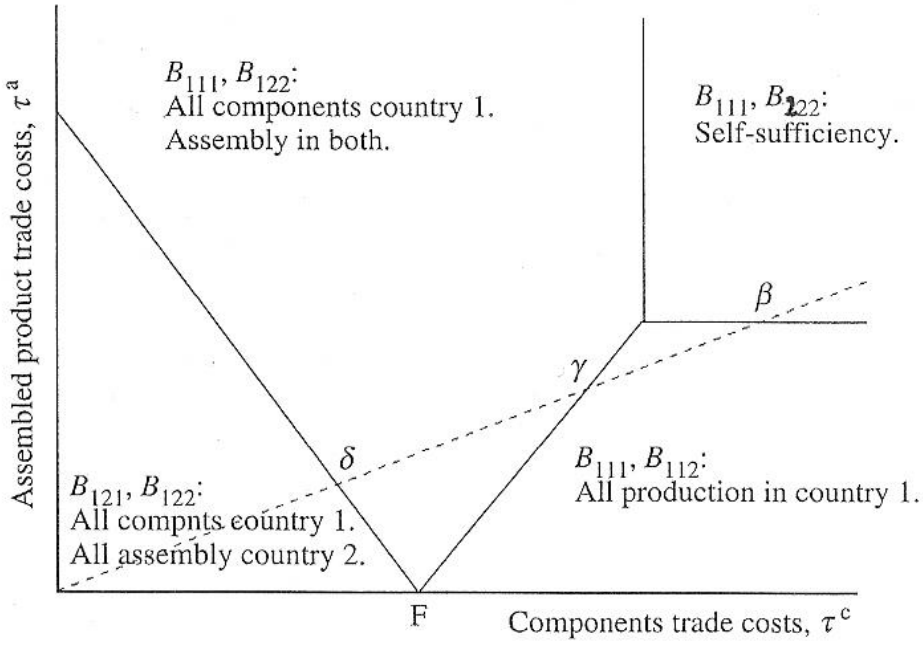


Figure 4.1. Assembly labour intensive; country 1 high wage.

This graph has the trade costs of components and of assembly. The lines demarcate the different combinations of possibilities.
Left bottom: VFDI
Upper left/middle: HFDI
Self-sufficiency: Autarky
Right bottom: Trade

Value added effects of FDI

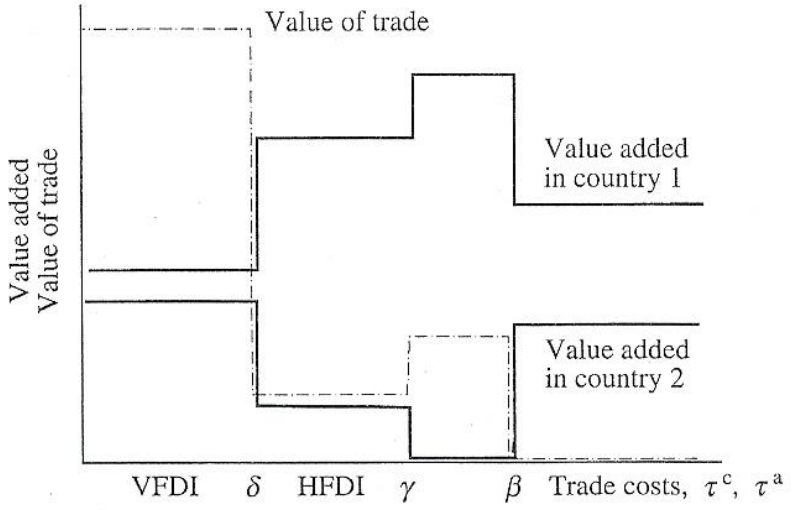


Figure 4.2. Assembly labour intensive; country 1 high wage.

They looked at combinations of component trade costs and assembly trade costs.
If both low, VFDI and trade. If you move to HFDI, there is much less trade going on. If you move to the trade part, no value added in country 1 because everything happens there. Self-sufficient some in country 1 and some in country 2. They assume a bigger market in country 1 than in country 2.

Other effects of FDI

FDI leads to increase in production, employment and wages. Are there more cherries to be picked?

- Increased exports
  - What if ToT deterioration?
- Increased tax revenues
  - Loss of control over domestic policy?
- Economies of scale
- Provision of technical and managerial skills
  - Due attention for development of local education and training of skills?
- Decrease of power domestic monopolies
  - Inception of local monopoly?

And what about….

- Increase in unemployment if K-intensive production?
- Decrease in domestic savings and/or investments due to FDI?
- Instability of balance of payments because of more export?

Lecture 3

Impact on home and host countries (empirical issues)
How to measure it and how to test?

Impact of FDI – overview
• **Host Country Effects**:
- Aggregate effects
- Compositional effects:
  - Productivity, factor markets (wages, skills), employment volatility

  → MNEs are often bigger than the firms in the host country.
- Behaviour of local firms:
  - Competition, pecuniary externalities and technological spillovers

  → When MNEs enter the market, also the behaviour of local companies can change. They can imitate what the MNEs are doing for example.

Aggregate effects of FDI
• FDI and economic growth → this is the most common way to measure it. See how FDI affects the growth of the host country.
- Cross-country studies → Many different countries to compare. Or for one country.
- Data: FDI data (balance-of-payment statistics)
- Functional form? → Variable of interest is FDI and growth the dependent variable.
- Conditional effects
  - Examples?

    → Does it always happen? The same for every (type) of country?

    → How well the country is able to imitate / absorb the firms that are coming in? The more high-skilled people, the more likely to benefit from the spillovers.
  - How to model that?

    → How would you modify the equation that you estimate to capture those effects?

    → Dummy of highly developed and not. Coefficient would capture the effect of being a highly developed country on economic growth. They have more growth.

    → Does the effect of FDI differ or is it moderated by being a developed country or not?

$$g = c_0 + c_1 FDI + c_2 FDI \times H + c_3 H + c_4 Y_0 + c_5 A$$

- Country studies

Other possible aggregate effects of FDI?
→ We care not only about growth, but also broader aspects.
• Example:
- Does FDI reduce poverty in Africa?
- Does FDI reduce poverty more in some African regions than in others?

$$\text{Welfare} = \alpha + \beta \times \text{FDI} + \sum \gamma_{1i} \times \text{Economic \& Policy } var_i + \sum \gamma_{2j} \times \text{Business Env. \& Inst. } var_j + \sum \gamma_{3k} \times \text{Political Risks } var_k + \varepsilon \quad (1)$$

where welfare is measured by HDI or real *per capita* GDP, FDI is measured by *per capita* FDI, the ratio of FDI to GDP, or the ratio of FDI to GCF, and the control variables are the economic and policy variables, the business environment and institutional quality variables, and the political risk

→ They don't only look at GDP growth, but also a dependent variable welfare. This captures also health and human capital. They control for institutional quality, not interested in the conditional effect. Assuming that the countries are the same, what is the effect of FDI on welfare?

Results:
→ First only the effect of different measures of FDI. Divided by population, divided by population square. Why does it make sense to look at different measures? The sign of the coefficients could change, so the results are not very robust. They could give different results. So by adding more measures, they say the measures are robust and they all find positive effects.
→ Later they add the control variables. Doesn't really make a difference, results stay mostly significant.
→ But the problem is that the endogeneity problem can go both ways. If the direction can go two ways, we could have the endogeneity problem. They try to solve that with a technique.
→ Unit of analysis is a country, because they look at the fixed effects.

Compositional effects
→ Wages, skills, employment volatility. They can all change.
Firm productivity
• Measures? Unit of analysis?
→ We look at firms now, not at a country anymore. We look at the differences between MNEs and local firms. In the UK there are way more national firms than MNEs and there are different measures of productivity. On average, MNEs are more productive and perform better than local firms, in UK.
→ But, we are comparing MNEs to all local companies. Can all of them compete with MNEs? The MNEs are some of the best companies that come to the UK. It's not fair to compare them with all small, medium etc. local companies in the UK. You would have to control for the size in our model to tease out those effects.
• Models:

$$\ln(q_t^k) = \alpha + \sum_{i=1}^{n}(\beta_i \mathrm{MNE}_{it}^k) + \sum_{s=1}^{v}\gamma_s X_{st}^k + e_t^k$$

Firm level productivity. Being a MNE on the right side and some controls.
• If the dataset is a panel?

$$e_t^k = \rho^k + \psi_t + \varepsilon_t^k.$$

→ There are different aspects that we might not be able to directly capture, that will go to our error term.
→ Ownership could also be a measurement. How the degree of ownership affects the performance.

Factor markets
• Concerns with MNEs:
- Paying workers in developing countries too little (the sweatshop problem).
- Whether create or deprive host economies of their skilled labour.
  → Are the skilled workers all moving to MNEs and the local firms are struggling to find workers?
- Volatile, responding rapidly to output and factor price shocks by laying off workers and transferring their activities elsewhere.
  → Would that affect the way workers are treated and paid?

→ Two options: They pay higher or lower.
• Why would MNEs pay higher wages?

→ Workers are more productive, so they are rewarding them. Assuming the workers remain the same in productivity, there might be regulations in the local country that force the MNEs to pay them higher. When MNEs enter, they don't necessarily know the market well and they might have search costs to find the workers and pay them higher. They want to make sure that the workers keep the secrets and technology in their own company, so they pay them more. Or they have payment schemes to pay them the same in all countries.

• Why wouldn't they pay higher wages?

→ They might be in a monopolistic position and have the power to keep the wages lower for them.

• Policy implications

• Wages & Skills (Lipsey & Sjoholm, 2004)

→ This is one of the first papers that has the skills and education of the workers. Three types of ownership. Local, foreign and government ownership. And other firm-specific controls.

$$\ln W = f(\text{Foreign owner, Government owner, Education, Sector, Location, } \ln X),$$

• Where W is a plant's average wage (separately for blue- and white-collar employees), Education is the education level of the employees (the share of the employees with below primary, junior, senior and university education), Sector and Location are dummy variables for industries and provinces, and X is a vector with plant specific characteristics

- Data: All plants in the manufacturing sector with more than 20 employees; Indonesia, 1996
- Why MNEs would pay higher wages?

FDI & Child Labour

• The impact of FDI on the relative wages of unskilled labour.

- FDI increases the demand for low wage, unskilled labour (of the type that children provide) vs.
- Multinational corporations often seek out relatively skilled workers → FDI would lower the relative wage of unskilled workers.

• The impact of FDI on family income → household with higher earnings will increase its consumption of child labour substitutes.

• Results (Davies & Voy, 2009): $\text{child labor}_i = \beta_0 + \beta_1 \ln(\text{FDI}_i) + \beta_2 \ln(\text{size}_i) + \varepsilon_i$

- Negative and highly significant coefficient on FDI.
- The significance of FDI goes away at the inclusion of per capita income.

Behaviour of local firms

The main channels by which the effects of MNEs are transmitted to domestic firms.

• Which effects?

• Which channels?

Which effects (types of externalities)?

• Technological externalities

- Technological since affecting other firms' production function.
- Externality: involuntary exchange of ideas.
- a.k.a. knowledge spillovers → clearly distinct from knowledge transfer, but is of course related to it.

• Pecuniary externalities

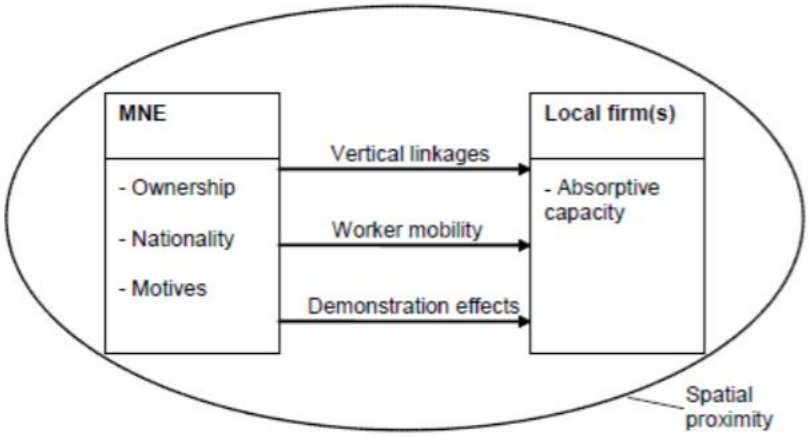
- Externalities that affect firms through prices and costs.
- May be through existing demand and supply linkages, but also because of newly created markets.

Transmission of channels?

• Competition
  - Negative product market competition effects? → less productive firms exit.
  - Also effect on firms in supply and demand chain? → net effect unclear (changed prices, changed number of inputs, etc.).
  - Labour hoarding effects? → MNEs pay higher wages and local firms must follow suit or settle for less productive labour.
  - Local firm investment effect? → MNEs trigger local firms to become innovative and become more efficient.
• Imitation and demonstration
  - See and imitate best practices in industry.
  - May concern products and processes.

Channels for externalities?
• Worker mobility and spin-offs
  - Former MNE employees who start working for local firms (mobility) or begin their own business (spin-off).
  - May involve pecuniary externality (saves local firms cost of training) and knowledge spillovers (tacit knowledge).
  - Only externality when not included in wages.
• Backward and forward linkages
  - Creation of demand (forward) and supply (backward) linkages plus effects of competition effects in upstream or downstream markets.
  - May also involve knowledge spillovers, f.i. because when MNEs must transfer knowledge to secure input quality.

Factors important for knowledge spillovers? (Smeets, 2008)



Are transmission channels also relevant for other externalities than K-spillovers?
(Castellani & Zanfei, 2005)

Table 5.1 A taxonomy of channels and types of externality

Channels	Pecuniary Externality	Knowledge Externality
Competition	***	*
Imitation/Demonstration	*	***
Labour Mobility	***	**
Linkages	***	***

Effects on domestic activities – empirics

• Does foreign ownership in an industry affect the productivity of domestically owned firms in the same industry?

$$Y_{ijt} = C + \beta_1 DFI\_Plant_{ijt} + \beta_2 DFI\_Sector_{jt} + \beta_3 DFI\_Plant_{ijt} * DFI\_Sector_{jt} + \beta_4 \mathbf{X}_{ijt} + \varepsilon_{ijt}.$$

Beta 2 coefficient sign?
Beta 3 coeff sign?

(Aitken & Harrison, 1999)

- years covered include 1976 through 1989

	Impact of direct foreign investment (DFI) on productivity	
	OLS with industry dummies[b] (1)	OLS without industry dummies (2)
Foreign ownership in the plant (*Plant_DFI*)	0.105	0.158
	(0.027)	(0.028)
Foreign ownership in the sector (*Sector_DFI*)	−0.267	0.058
	(0.061)	(0.030)
*Plant_DFI * Sector_DFI*	0.356	−0.212
	(0.181)	(0.189)
Number of plants	10,257	10,257
Number of observations	43,010	43,010
Hausman test[f]	38.4	—
R^2	0.96	0.95

Impact of FDI – Overview

• Home Country Effects:

- Production
- Employment → Substitutes or complements with production?
- Skill mix and relative wages
- Technology upgrading
- Productivity

The relationship between foreign production and exports from the home country
• Complementarity or substitution?

Output and trade
• Findings: in general, complementarity.
• Limitations:
  - Endogeneity
  - Distinction between horizontal and vertical FDI

Skill intensity

"Currently, for example, Japan imports 23 times as many television sets as it exports. They are all assembled in Japanese-owned factories in places like Malaysia and Thailand . . . By the year 1998, Toyota expects that 65% of the cars it sells around the world will be made outside Japan'. Over the corresponding period, Japanese firms have also increased the share of the wage bill attributable to nonproduction workers, suggesting a demand shift away from workers with low skills."

Time magazine (April 22, 1996, p. 60)

$$SH_{St}^k = \beta_0 + \beta_1 \ln w_{Ut}^k + \beta_2 \ln w_{St}^k + \beta_3 \ln \frac{K_t^k}{Y_t^k} + \beta_4 \ln Y_t^k + \beta_5 MNE_t^k + e_t^k.$$

MNE measures the importance of multinational activities for firm k at time t, proxied by?

• which coefficient are we interested in?

• what would its sign imply?

• HFDI vs VFDI?, VFDI in high-income vs low-income country?

Overseas employment and the use of nonproduction workers

	Dep. var.: nonproduction share of the wage bill					
Sample	1070 Manufacturing firms			154 Electronics firms		
Period	65–90	65–79	80–90	65–90	65–79	80–90
Specification	(1)	(2)	(3)	(4)	(5)	(6)
Log assets/value-added	−3.80[a]	−2.81[a]	−3.42[a]	−0.93[a]	−1.66[a]	−0.81[c]
	(0.12)	(0.16)	(0.16)	(0.31)	(0.38)	(0.47)
Log value added	−3.33[a]	−1.81[a]	−3.91[a]	0.62[c]	−0.86[b]	−1.97[a]
	(0.13)	(0.17)	(0.21)	(0.32)	(0.39)	(0.60)
Overseas employment share	[redacted][a]	[redacted][a]	[redacted][a]	[redacted][a]	[redacted][a]	[redacted][a]
	(1.31)	(1.71)	(1.87)	(1.83)	(2.20)	(2.25)
Overseas share×income	[redacted]23[a]	[redacted][a]	[redacted]0[a]	[redacted]7[a]	[redacted]5	[redacted]0[a]
	(1.66)	(2.49)	(2.06)	(2.73)	(3.51)	(3.28)
Residual change	16.68[a]	6.97[a]	7.47[a]	−1.41	0.40	4.76[a]
	(0.69)	(0.55)	(0.24)	(1.98)	(1.46)	(0.72)
N	25,131	13,551	11,580	3606	1933	1673
R^2	0.281	0.168	0.203	0.236	0.231	0.184
RMSE	6.248	4.756	4.299	5.488	3.903	4.163

Standard errors in parentheses with a, b, c and denoting significance at the 1%, 5%, and 10% level.

With panel data you can get a step closer to tackling causation.
Econometrics looks at the question of causality, that's the difference between statistics and econometrics.

Cross-sectional data = A dataset that looks at different industries at one point in time.
Time series data = Data from different points in time for one industry.
Panel data = The two above combined. You have two dimensions (so more data) and two types of pooled data.

- Independent pooled data → The units are independently pooled from our sample population.
- Panel data → Not independently distributed across time.

Pooled Cross Sections

- Population surveys - each period, Statistical Bureau independently samples the population.
  → At each period the sample is different, they ask different people / firms every year.
- Independent cross-sections but we can take time into account.

Panel Data

- Each year, a researcher surveys the same firms on a range of questions: financial performance, employees, innovation output, etc.
  → They ask the same people / firms every year.
- Cross-sections with time order.
- Observations for each individual with temporal ordering.
- Sample does not change.

Pooled cross sections are often used by policy makers.

Pooling Independent Cross Sections Across Time

• If a random sample is drawn at each time period, resulting data are independently pooled cross sections.
• Reasons for pooling cross sections:

- To increase sample size ⇒ more precise estimators
  → You have more information, so more reliable and more variation. More different points in time, so your precision of your estimations will increase.
- To investigate the effect of time.
  → The houses are different, but we can still analyse the trend.
- To investigate whether relations have changed over time.
- Policy analysis.

• We may assume that parameters remain constant.

$$Y_{it} = \beta_0 + \beta_1 X_{it} + u_{it}$$

• We may investigate the effect of time (Example 13.1)

$$Y_{it} = \beta_{0t} + \beta_1 X_{it} + u_{it}$$

• We may investigate whether relationships have changed over time (Example 13.2)

$$Y_{it} = \beta_0 + \beta_{1t} X_{it} + u_{it}$$

Relationship between x and y can change over time.
The effect of time

• National Opinion Research Center's General Social Survey for even years from 1972-1984

$$kids_{it} = \beta_0 + \beta_1 d74_{it} + \cdots + \beta_6 d84_{it} + \beta' x_{it} + u_{it}$$

The population is different every year, but the trend remains.
We have dummies here for year. The dummy is added to the intercept.

$$d74_i = 1 \text{ if year} = 74, 0 \text{ otherwise (year dummy)}$$
$$\mathbf{x}_i = (educ_i, age_i, age_i^2, black_i, east_i, \ldots, smcity_i)$$

Question: After controlling for observable factors (educ, etc.), what has happened to fertility over time? → Fertility is number of children a person has.
You can find this information in the dummy for 1974, the beta 0 + beta 1.
Beta 0 is the natural rate of fertility. If we are interested in the change, we look at adding the increase of the actual rate. That would be the coefficient.
(Check all of this in the reader or Internet)

$$E[kids_i|\mathbf{x}_i, year = 72] = \delta_0 + \beta'\mathbf{x}_i$$
$$E[kids_i|\mathbf{x}_i, year = 74] = \delta_0 + \delta_1 + \beta'\mathbf{x}_i$$

We have our expectations of the number of kids, given all our controls.
Hence:

$$E[kids_i|\mathbf{x}_i, year = 74] - E[kids_i|\mathbf{x}_i, year = 72] = \delta_1$$

→ The change in fertility between 1972 and 1974 controlling for xi
There are some complications.

- What happens to the relationship, because not all factors may be constant over time.
- The variance of the error term Var(u_it) may change over time. The variance is not constant. We might have heteroskedasticity. You have to check for it and the solution in Stata is to do a Robustness test.

Investigate whether relationships have changed over time
• To allow coefficients on x_i to vary over time → interaction terms with the dummy variable:

$$\log(wage) = \beta_0 + \delta_0 y85 + \beta_1 educ + \delta_1 y85 \cdot educ + \beta_2 exper + \beta_3 exper^2 + \beta_4 union + \beta_5 female + \delta_5 y85 \cdot female + u,$$

The time dummies can interact to see if they change over time. We might expect, test, if the relationship between education and wages has changed over time.
• y85 is a dummy equal to 1 if observation is from 1985 and zero if it comes from 1978.
→ We have the dummy for 1985, then it is 1, and for 1978, then it is 0. So two years of data.
• The intercept for 1978 is Beta 1 and intercept for 1985 is year dummy + original intercept 1978.
Question: What is the return to education in 1978? and in 1985?
Is being more educated beneficial? Look at the interaction between education and the year 1985. In 1978 it is beta 1. Does it have to be bigger for 1985? If there is anything positive that you are adding, it means it increased. It is not about the size of the correlation, it has to be positive.

This is why:

$$\log(wage) = \beta_0 + \delta_0 y85 + \beta_1 educ + \delta_1 y85 \cdot educ + \beta_2 exper + \beta_3 exper^2 + \beta_4 union + \beta_5 female + \delta_5 y85 \cdot female + u,$$

Then

$$E[\log(wage)_i | educ_i, exper_i, union_i, female_i, year = 78] = \beta_0 + \beta_1 educ + \beta_2 exper + \beta_3 exper^2 + \beta_4 union + \beta_5 female + u$$

$$E[\log(wage)_i | educ_i, exper_i, union_i, female_i, year = 85] = \beta_0 + \delta_0 + \beta_1 educ + \delta_1 educ + \beta_2 exper + \beta_3 exper^2 + \beta_4 union + \beta_5 female + \delta_5 female + u$$

And

$$E[\log(wage)_i | educ_i, exper_i, union_i, female_i, year = 85] - E[\log(wage)_i | educ_i, exper_i, union_i, female_i, year = 78] = \delta_0 + \delta_1 educ + \delta_5 female$$

Q: Has the return to education changed over time?

Now we have the data and our estimated coefficients:

$$\log(wage) = .459 + .118\, y85 + .0747\, educ + .0185\, y85 \cdot educ$$
$$(.093)\ (.124)\ (.0067)\ (.0094)$$
$$+ .0296\, exper - .00040\, exper^2 + .202\, union$$
$$(.0036)\ (.00008)\ (.030)$$
$$- .317\, female + .085\, y85 \cdot female$$
$$(.037)\ (.051)$$
$$n = 1{,}084,\ R^2 = .426,\ \bar{R}^2 = .422.$$

The additional year gives you a 7 percent higher rate, so there is a positive return. This is in the base year.

Now we want to look at the change. An additional year of education gives you a salary of 9 percent higher.

The 0.459 means the general effect on wage, what happens to wages.

0.118 is for the year 1985, when we add that to the wage. Wages are increasing, because the coefficient is positive, controlling for all other factors.

• We can test the null hypothesis that nothing has changed over the period:

H0: δ1 = 0 to the alternative that the effects has changed

H1: δ1 ≠ 0

Policy analysis with pooled cross sections:

• Two or more independently sampled cross sections can be used to evaluate the impact of a certain event or policy change.

→ Helps us to look over time and how the relationship changed over time.

• Event or policy intervention must be a "natural experiment" - i.e., must be exogenously imposed on data.

→ It should be exogenous.

• A natural experiment always has:

- A control group, which is not affected by the policy change,
- A treatment group, which is affected by the policy change.

• Idea: Compare the change in outcomes across the treatment and control groups to estimate the policy effect.

→ The x should not be in any way be related to the error term. If you can expect from theory that your y influences your x, then endogeneity. That can mess up our model.

Example: Effect of new garbage incinerator's location on housing prices (Wooldridge, Ex.13.3.)
• Examine the effect of the location of a house on its price before and after the garbage incinerator was built:

- 2 year pooled cross section of data for 1978 and 1981
- New incinerator built in 1981 and online in 1985
- Knowledge of incinerator project not known in 1978

$$\widehat{rprice} = \underset{(3,093.0)}{101,307.5} - \underset{(5,827.71)}{30,688.27}\, nearinc$$

After incinerator was built

$$n = 142, R^2 = .165$$

$$\widehat{rprice} = \underset{(2,653.79)}{82,517.23} - \underset{(4,744.59)}{18,824.37}\, nearinc$$

Before incinerator was built

$$n = 179, R^2 = .082$$

$$E[rprice_i|nearinc_i = 1 \text{ in } 1981] - E[rprice_i|nearinc_i = 0 \text{ in } 1981] = \gamma_1 = -30,688$$

Radboud University Nijmegen

Locating a garbage incinerator, how that effects the housing prices.
We have two years of data and the knowledge of this project was not known in 1978. The market was not reacting to the policy change yet.
Question: Did house values near the incinerator decline in value?
Our dummy is if the houses are near the incinerator or not. There is a strong negative effect of being near the incinerator. It shows that houses near it have lower prices.
• It would be wrong to conclude from the regression after the incinerator is there that being near the incinerator depresses prices so strongly

- One has to compare with the situation before the incinerator was built:

The trend was already decreasing, so we don't know it that's because the incinerator. It doesn't really help us to tackle the causality issue here. We need to compare the two. Does our coefficient after it was built change? The difference between the tw
o gets us closer. It is still negative, but much lower effect.

$$\hat{\delta}_1 = -30,688.27 - (-18,824.37) = -11,863.9$$

Incinerator depresses prices but location was one with lower prices anyway

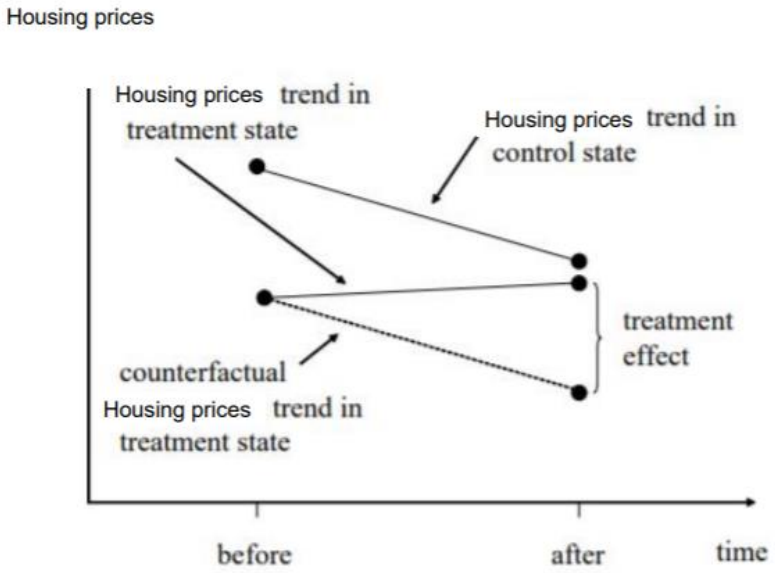
- In the given case, this is equivalent to

$$\hat{\delta}_1 = (\overline{rprice}_{1,nr} - \overline{rprice}_{1,fr}) - (\overline{rprice}_{0,nr} - \overline{rprice}_{0,fr})$$

- **This is the so called difference-in-differences estimator (DiD)**

It is a very powerful way to measure the effects.

Causal effects in the difference-in-differences model:



We assume what could have happened if the incinerator was not built. What happened to the crisis? Prices would also go down. The difference between what happened and what we would expect before it happened is the treatment effect.

Difference-in-differences in a regression framework:
We can put everything together in one model, you don't have to do it for every year.

$$rprice = \beta_0 + \delta_0\, after + \beta_1\, nearinc + \delta_1\, after \cdot nearinc + u$$

Differential effect of being in the location and after the incinerator was built

- In this way standard errors for the DiD-effect can be obtained.
- If houses sold before and after the incinerator was built were systematically different, further explanatory variables should be included.
- This will also reduce the error variance and thus standard errors.

Here we have a simple model. Normally you would add something else. Are there any other things that effect the housing crisis? There are many other (control) factors. To improve the model, we can add more controls.

• Before/After comparisons in "natural experiments"
  - DiD can be used to evaluate policy changes or other exogenous events

$$rprice_i = \beta_0 + \delta_0 d81_i + \beta_1 nearinc_i + \delta_1 (d81_i \times nearinc_i) + \varepsilon_i$$

Then

$$\begin{aligned}
E[rprice_i|nearinc_i &= 1,\ d81_i = 1] = \beta_0 + \delta_0 + \beta_1 + \delta_1 \\
E[rprice_i|nearinc_i &= 0,\ d81_i = 1] = \beta_0 + \delta_0 \\
Diff_{81} &= \beta_1 + \delta_1 \\
E[rprice_i|nearinc_i &= 1,\ d81_i = 0] = \beta_0 + \beta_1 \\
E[rprice_i|nearinc_i &= 0,\ d81_i = 0] = \beta_0 \\
Diff_{78} &= \beta_1 \\
Diff_{81} - Diff_{78} &= \delta_1
\end{aligned}$$

Policy evaluation using difference-in-differences:

Always have the control and the treatment group before and after the event happened.

$$y = \beta_0 + \delta_0 after + \beta_1 treated + \delta_1 after \cdot treated + other factors$$

$$\hat{\delta}_1 = (\bar{y}_{1,T} - \bar{y}_{1,C}) - (\bar{y}_{0,T} - \bar{y}_{0,C})$$ ← Compare outcomes of the two groups before and after the policy change

Group	Period 1	Period 2	
Control	before	after	Diff
Treatment	before	after	Diff
			Diff in Diff

Why include controls?

Two-period panel data analysis

• Observe cross section on the same individuals, cities, countries etc., in two time periods t_1 and t_2

• Panel data structure makes it possible to deal with certain types of endogeneity.

→ All the examples were for pooled cross sections, but what to do when you have a panel section? In panel data you have information for the same information for the different years, that would be even better.

• Extends the natural experiment framework to situations in which there may be endogeneity

Example: Effect of unemployment on city crime rate

- Data on crime and unemployment rates for 46 cities for 1982 and 1987.
- Regression for 1987:

$$\widehat{crmrte} = 128.38 - 4.16\, unem$$
$$(20.76)\ \ (3.42)$$
$$n = 46,\ R^2 = .033.$$

→ 4.16 unem → what does it tell us? That unemployment has a negative effect on the crime rate. But it's not really significant. Not significant, so no relationship. But if it was significant, it would be negative. You would expect the relationship would be positive, from theory.

- Assume that no other explanatory variables are available. Will it be possible to estimate the causal effect of unemployment on crime?
- Yes, if cities are observed for at least two periods and other factors affecting crime stay approximately constant over those periods E.

When we have two time periods, we can split our error term. Some factors don't change over time, fixed effects. For example geographical location, that usually doesn't change over time.

$$crmrte_{it} = \beta_0 + \delta_0\, d87_{it} + \beta_1\, unem_{it} + a_i + u_{it},\ t = 1982, 1987$$

Time dummy for the second period

Unobserved time-constant factors (= fixed effect)/ unobserved heterogeneity

Other unobserved factors (= idiosyncratic error)

• How should we estimate the parameter of interest, B_1?

We have panel data, so data for the same cities for two years.

- Pool the two years and use OLS? It might be not the best idea, could be biased.

Eliminating endogeneity in two period panel data:

$$crmrte_{it} = \beta_0 + \delta_0\, d87_{it} + \beta_1\, unem_{it} + a_i + u_{it},\ t = 1982, 1987$$

Then

$$crmrte_{i1987} = \beta_0 + \delta_0 \cdot 1 + \beta_1\, unem_{i1987} + a_i + u_{i1987}$$

$$crmrte_{i1982} = \beta_0 + \delta_0 \cdot 0 + \beta_1\, unem_{i1982} + a_i + u_{i1982}$$

Subtract $\Rightarrow \Delta crmrte_i = \delta_0 + \beta_1 \Delta unem_i + \Delta u_i$

Fixed effect drops out („differenced away")

- **Estimate differenced equation by OLS:**

$$\widehat{\Delta crmrte} = \underset{(4.70)}{15.40} + \underset{(.88)}{2.22}\,\Delta unem$$

+ 1 percentage point unemployment rate leads to 2.22 more crimes per 1,000 people

Secular increase in crime

$$n = 46, R^2 = .127$$

What we can do is subtract.
The trick to eliminate is to differentiate your data.
We have the fixed effect that doesn't change over time, when differentiating it goes away. The part of that error term will go away.

But there are costs of differencing.
We have two years of data and took the difference, so we end up with not so many observations anymore. This means our analysis is less precise because there are less observations. We have less variance and larger standard errors, so our estimates will be less precise.

Policy Analysis with Two-Period Panel Data
• Two period panel data is often used for program evaluation studies in which there is likely to be endogeneity.
• Example: Evaluation of Michigan Job Training Program.
- Data for two years (1987 and 1988) on the same manufacturing firms in Michigan.
- Some firms received job training grants in 1988 and some did not (training was available on first come first serve basis).

Policy analysis with two-period panel data

• Panel data regression

$$
\begin{aligned}
scrap_{it} &= \beta_0 + \delta_0 \times d88_t + \beta_1 grant_{it} + a_i + u_{it} \\
scrap_{it} &= \text{scrap rate (\% of items scrapped due to defects)} \\
grant_{it} &= \text{1 if firm } i \text{ received a training grant in 1988} \\
a_i &= \text{unobserved firm fixed effects (e.g. worker productivity)} \\
cov(grant_{it}, a_i) &\neq \text{0 (why?)}
\end{aligned}
$$

First Difference transformation

$$
\begin{aligned}
\Delta scrap_{it} &= \delta_0 + \beta_1 \Delta grant_{it} + \Delta u_{it} \\
&= \delta_0 + \beta_1 grant_{i88} + \Delta u_{it}
\end{aligned}
$$

• Here, B_1 = "average treatment effect"

Did this policy help or not?

• Estimation

$$
\begin{aligned}
\widehat{\Delta scrap}_{it} &= \underset{(.405)}{-.564} - \underset{(.683)}{.739}\, \Delta grant_{it} \\
n &= 54,\ R^2 = .022 \\
t_{\beta_1=0} &= \frac{-.739}{.683} = 1.08
\end{aligned}
$$

It doesn't have to be two time periods, it can be more.

Differencing with multiple periods

• A general fixed effect model (T=3)

$$y_{it} = \delta_1 + \delta_2 d2_t + \delta_3 d3_t + \beta_1 x_{it1} + \ldots + \beta_k x_{itk} + a_i + u_{it},$$

• We can simply estimate by OLS, assuming ….

$$\Delta y_{it} = \delta_2 \Delta d2_t + \delta_3 \Delta d3_t + \beta_1 \Delta x_{it1} + \ldots + \beta_k \Delta x_{itk} + \Delta u_{it},$$

• So if 3 periods, then subtract period 1 from period 2, period 2 from period 3 and have 2 observations per individual.

$$\Delta y_{it} = \alpha_0 + \alpha_3 d3_t + \beta_1 \Delta x_{it1} + \ldots + \beta_k \Delta x_{itk} + \Delta u_{it}, \quad \text{for } t = 2 \text{ and } 3.$$

• We can simply further extend to T periods.

• Correlation and heteroskedasticity are treated in the same way as in time series data.

Lecture Econometrics 2

Panel data – two types: fixed effects and random effects

Different time periods and for each one you have a different sample. Every year a different sample of people that is surveyed. Other type is the same person, house etc. that you have data for every year. For each entrepreneur, we have data for each year. That is balanced panel.

If you miss some data for some entrepreneurs, that is unbalanced panel.

Short and long panel is between the time they mention in our data. Lots of units and short time frame, that is a short panel. Long time frame and not a lot of units, that is long panel. 100 years of observations

and only 20 entrepreneurs is a long panel. 20000 people surveyed in a given year and surveys for 5 years, that is a short panel.
How to eliminate the fixed effect? For example the skills of an entrepreneur don't change over time, but different entrepreneurs have different skills. We took one year from the other. Take the first difference of the data. Basically subtracting one year from the other.
Why is it a problem to have a fixed effect? It doesn't change over time.
Today we look at another trick.

Fixed effects estimation

- First differencing is just one of the ways how to eliminate the fixed effect a_i
- An alternative is called fixed effects transformation
- Consider a model:

Fixed effect, potentially correlated with explanatory variables

$$y_{it} = \beta_1 x_{it1} + \ldots + \beta_k x_{itk} + a_i + u_{it}, \; i = 1, \ldots, N, t = 1, \ldots, T$$

- For each i, we average this equation over time:

Form time-averages for each individual

$$\bar{y}_i = \beta_1 \bar{x}_{i1} + \ldots + \beta_k \bar{x}_{ik} + \bar{a}_i + \bar{u}_i$$

$$\Rightarrow [y_{it} - \bar{y}_i] = \beta_1 [x_{it1} - \bar{x}_{i1}] + \ldots + \beta_k [x_{itk} - \bar{x}_{ik}] + [u_{it} - \bar{u}_i]$$

$$a_i - \bar{a}_i = 0$$

In panel data, the error term is very often split into two. The first part is the fixed effect, the second part with the t is the part that does change over time.
One way to eliminate that part is to take the average over time. For each i we take the average of all the time periods.

$a_i - \bar{a}_i = 0$ This one doesn't change over time, so each ai – average is 0.

Fixed effects estimation takes the averages over time for each individual. After that we can apply regular OLS.

- Subtracting the averages from original equation, we will get time-demeaned data

$$\ddot{y}_{it} = \beta_1 \ddot{x}_{it1} + \beta_2 \ddot{x}_{it2} + \ldots + \beta_k \ddot{x}_{itk} + \ddot{u}_{it}, \quad t = 1, 2, \ldots, T,$$

where $\ddot{y}_{it} = y_{it} - \bar{y}_i$ and similarly for $\ddot{x}_{it}$ and $\ddot{u}_{it}$

- Estimate time-demeaned equation by OLS
  - Uses time variation within cross-sectional units (= within estimator/fixed effects estimator)
  - Assumptions? Limitations?
- Between estimator
  - obtained as the OLS estimator on the time averages

$$\bar{y}_i = \beta_0 + \beta_1 \bar{x}_i + a_i + \bar{u}_i.$$

  - biased when … ?
  - If we think a_i uncorrelated with x_it → RE better

Time demeaned data. For all the data that we have we can take the average.
What are the assumptions in the model?

- Samples are normal distributed
- Error terms are exogenous
- Variance is constant → homoscedastic

Do you see any limitations of taking away the averages?
Gender for example also doesn't change over time. So you also take away that part with the average. You cannot estimate the effect of gender on performance (if that's your model).
You reduce how much information your model is giving. To keep taking into account the time indication, the random effects will be better.

Example for fixed effects estimation:
Each year we have information about each firm → balanced panel.
Some firms in the data got a grant, to improve, some don't.
We want to see if those grants are helping the companies to perform better.

$$scrap_{it} = \beta_1 d88_{it} + \beta_2 d89_{it} + \beta_3 grant_{it} + \beta_4 grant_{it-1} + a_i + u_{it}$$

Time-invariant reasons why one firm is more productive than another are controlled for.
The important point is that these may be correlated with the other explanat. variables.

Fixed-effects estimation using the years 1987, 1988, and 1989:

Stars denote time-demeaning

$$\widehat{scrap}^*_{it} = -.080\ d88^*_{it} - .247\ d89^*_{it} - .252\ grant^*_{it} - .422\ grant^*_{it-1}$$
$$(.109) \qquad (.133) \qquad (.151) \qquad (.210)$$

$$n = 162, R^2 = .201$$

Training grants significantly improve productivity (with a time lag)

Lagged variable for the grant. Three time periods and two time dummies. The reference category is dropped. And we have our error terms split up into two parts. Fixed effect that doesn't change and the part of the error term that does change over time.
Compared to base year, in 89 on average there is a lower scrap rate. That's what the -.247 indicates.
Over the years the companies are doing better, but not due to the grant. Could be technological improvement.
-.252 and -.422 indicate that getting a grant improves performance.
Getting a grant the previous year, how does that influence your performance this year. The effect of the grant carries over to next year. In the first year you have some time to implement it, but in the next it can have more effects. It takes some time for it to have effect. Having panel data allows that.

Discussion of fixed effects estimator

- Strict exogeneity in the original model has to be assumed → Error term should not be correlated.
- The effect of time-invariant variables cannot be estimated → cannot look at effect of gender on performance.
- But the effect of interactions with time-invariant variables can be estimated (e.g. the interaction of education with time dummies) → if we expect that some effects change over time, that is the part we can look at. Gender and time dummy, that is something that can be

estimated. Effect of education on your wages might change over time. Education can be constant, but the effect can change over time.

- If a full set of time dummies are included, the effect of variables whose change over time is constant cannot be estimated (e.g. experience) → Three years, so we put two of them. One is the reference year. If experience is measured by years worked at the company and you have yearly data, you can't estimate this because it changes at the same rate over time.
- The R-squared of the demeaned equation interpretation (◊ time variation!) → This is about time variation. Interested of what we can explain how that is related to time variation of the independent variation. What changes are driven by the independent variable should be changing over time with the time variation.

The dummy variable regression
Another way to do fixed effects is to have a dummy for each fixed effect.
The fixed effects estimator is equivalent to introducing a dummy for each individual in the original regression and using pooled OLS:

$$y_{it} = a_1 ind1_{it} + a_2 ind2_{it} + \ldots + a_N indN_{it} + \beta_1 x_{it1} + \ldots + \beta_k x_{itk} + u_{it}$$

For example, = 1 if the observation stems from individual N, = 0 otherwise

It will yield the same results as the fixed effects estimation.
Dummy for the fixed effect skill that we don't observe. For every person. But this might have some drawbacks. The coefficients will be the same. But, what could be the drawbacks of 50 dummies in your model if you have 50 companies?
If you have 20000 people, you have to add 20000 dummies. Then the output will be huge for what you see. The coefficients will be the same for the other variables, but you have a lot of additional variables in your model.
How do you judge if your model is good or not? R-squared. The more variables you have, the higher your R-squared will be. If you want to adjust for the number of variables that could be. But with this much dummies, it doesn't mean it's a very good model.

Fixed effects (FE) or first differencing (FD)?
• In the case T = 2, fixed effects and first differencing are identical
• For T > 2, fixed effects is more efficient if classical assumptions hold
• First differencing may be better in the case of severe serial correlation in the errors, for example if the errors follow a random walk
• If T is very large (and N not so large), the panel has a pronounced time series character and problems such as strong dependence arise ◊ first differencing
• Otherwise, FE more commonly used (but it can be a good idea to compute both and check robustness)

- Fixed effects are faster when implementing.
- The second method, the one from today, is more widely used.
- If we have a lot of time periods, compared to units, might imply that taking the first difference is better. Better correlations across time.

Unbalanced panels

- Panel data have often missing years for some cross-sections
- We simply use the time-demeaning of T_i observations in time for each cross-section i and FE is equivalent to an FE on balanced panel
- We should know the reason:

- Missing data for some i is not correlated with u_it
  → Missing data should be random, no correlation. Then you might have a bias.
- The reason of firm leaving the sample is correlated with unobserved factors in time and thus affects u_it → bias

Random effects model

• In FE or FD estimation, we would like to eliminate a_i because we think it is correlated with x_itj
• Now, suppose that a_i is uncorrelated with each explanatory variable at all periods, x_itj
→ FE and FD are inefficient as we eliminate a_i in this case Solution: use Random Effect Model

The individual effect is assumed to be "random" i.e. completely unrelated to explanatory variables

$$y_{it} = \beta_0 + \beta_1 x_{it1} + \ldots + \beta_k x_{itk} + a_i + u_{it},\ i = 1, \ldots, N, t = 1, \ldots, T$$

Random effects assumption: $Cov(x_{itj}, a_i) = 0, j = 1,2, \ldots, k$

for all $t = 1, 2, \ldots, T$ and $j = 1, 2, \ldots, k$.

Underlying assumption is that the individual effect is not correlated to explanatory variables.
Explanation of the random effects assumption:

The covariance between two random variables X and Y is defined as:

the expected product of their deviations from their individual expected values

i.e.: $\operatorname{cov}(X,Y) = \mathrm{E}\left[(X - \mathrm{E}[X])(Y - \mathrm{E}[Y])\right]$

Where where E[X] is the expected value of X → mean of X.

If X and Y are independent, then their covariance is zero.

Note: The variance is a special case of the covariance in which the two variables are identical

$$\operatorname{cov}(X,X) = \operatorname{var}(X) \equiv \sigma^2(X) \equiv \sigma_X^2.$$

Covariance is how one variable, x and y, varies with other variables. It's a correlation.
Correlation table is a normalized covariance thing. That's because you have more than two variables and you still want to compare them.
Important part is that the covariance is zero → underlying assumption.

If we throw away ai, we have less precise data.

• If we believe that a_i is uncorrelated with explanatory variables, OLS of simple cross-sections is consistent
• Do we need panel data at all?
  - We throw away useful information in the other time periods
• If we want to use this information, we can use pooled OLS estimation
  - But pooled OLS ignores the key feature of the model – serial correlation in the error term

When using normal OLS, less precise model. So pooled OLS can be better in this case.

Random Effects Models cont.

The individual effect is assumed to be "random" i.e. completely unrelated to explanatory variables

$$y_{it} = \beta_0 + \beta_1 x_{it1} + \ldots + \beta_k x_{itk} + a_i + u_{it},\ i = 1, \ldots, N, t = 1, \ldots, T$$

Random effects assumption: $Cov(x_{itj}, a_i) = 0, j = 1,2, \ldots, k$

The **composite error** $a_i + u_{it}$ is uncorrelated with the explanatory variables but it is serially correlated for observations coming from the same i:

$$Cov(a_i + u_{it}, a_i + u_{is}) = Cov(a_i, a_i) = \sigma_a^2$$

Under the assumption that idiosyncratic errors are serially uncorrelated

For example, in a wage equation, for a given individual the same unobserved ability appears in the error term of each period. Error terms are thus correlated across periods for this individual.

→ Because of this positive serial correlation, pooled OLS estimator will be incorrect

Estimation in the random effects model

- Under the random effects assumptions explanatory variables are exogenous so that pooled OLS provides consistent estimates
- But, because of the serial correlation, OLS is not correct (not efficient)
- One can transform the model so that eliminates serial correlation in the errors (GLS transformation)
  - The fixed effects estimator subtracts the time averages from the corresponding variable
  - The random effects transformation subtracts a fraction of that time average, where the fraction depends on σ_a^2, σ_u^2 and the number of time periods, T

$$[y_{it} - \theta \bar{y}_i] = \beta_1 [x_{it1} - \theta \bar{x}_{i1}] + \ldots + \beta_k [x_{itk} - \theta \bar{x}_{ik}]$$ ← Quasi-demeaned data

$$+ [a_i - \theta \bar{a}_i + u_{it} - \theta \bar{u}_i]$$ ← Error can be shown to be serially uncorrelated

→ Errors are now uncorrelated, and the GLS estimator is simply the pooled OLS of this transformation

Here, for every variable that we have we have the theta, so we take away a share of the average. That is estimated by the model, you can't decide it yourself.
Not fully demeaned, only a part is taken away.
The share is decided by the variation in the two parts of the error term. Varies by 0 to 1. The closer the theta is to 1, the closer to fixed effects. The closer to 0, the closer to regular OLS estimation.
Because you don't take away the full part, you can estimate factors that change over time.

with $\theta = 1 - \left[\sigma_u^2/(\sigma_u^2 + T\sigma_a^2)\right]^{1/2}$, $0 \leq \theta \leq 1$

- The quasi-demeaning parameter is unknown but it can be estimated
- GLS using the estimated θ is called random effects estimation (→ feasible GLS → FGLS)
- If the random effect (a_i) is relatively unimportant as it has small variance compared to the idosyncratic error (u_it), GLS will be close to pooled OLS (because $\theta \to 0$)
- If the random effect is relatively important compared to the idiosyncratic term, GLS will be similar to fixed effects (because $\theta \to 1$)
- Random effects estimation works for time-invariant variables

Random effects or fixed effects?

• We decide whether to use RE or FE based on a_i:
  - If unobserved effect is supposed to be random (random sample from a large population) → RE (e.g. class assignment, schools in a large country, sample of workers)
  - If unobserved effect is not random (e.g. states, provinces) → FE (RE inconsistent)
  - If we want to look at the difference over time, for example of gender, random effects is better.

• But, to treat a_i as random, we have to make sure that it is not correlated with explanatory variables (formal test) → Relates to the assumption of covariance. If observed effect is correlated with the variables, fixed effects is better and gives more precise effects of the coefficients.

• If unobserved effect a_i is correlated with explanatory variables, FE is consistent, while RE is inconsistent.

• Otherwise, RE is more efficient that FE.

In general, economists like fixed effects more.

• We can test whether to use FE or RE statistically: This is by the Hausman test

Haussman test

- $H_0 : cov(a_i, x_{it}) = 0$
- Under the null, **both FE and RE are consistent**, but **RE is asymptotically more efficient**.
- Under the alternative, FE is still consistent (RE is not).

If the assumption holds, then RE. If is doesn't, FE. In the test, it also tests how similar the coefficients are. If they are quite similar, we can use RE. if they are very different, probably they are violating the assumption and we need to use FE.

• We can test and correct for serial correlation and heteroskedasticity in the errors.

• We can estimate standard errors robust to both

Unbalanced panels

• Once the time averages have been properly obtained, using RE is the same as in the balanced case

• Still can use a test of statistical significance on the set of time averages to choose between fixed effects and pure random effects

• Key issue is understanding why the panel data set is unbalanced

There has to be some adjustment in the model to be made, but Stata does that for you.

Example
We are interested in how much people give to charity.
It's a panel. We have more units of observation than years, so it's a short panel. i is larger than t.

First just a simple OLS

```
reg charity age income price deps ms
```

Source	SS	df	MS
Model	181.689807	5	36.3379614
Residual	627.663928	464	1.35272398
Total	809.353735	469	1.72570093

Number of obs = 470
F(5, 464) = 26.86
Prob > F = 0.0000
R-squared = 0.2245
Adj R-squared = 0.2161
Root MSE = 1.1631

charity	Coef.	Std. Err.	t	P>|t|	[95% Conf.	Interval]
age	1.547275	.2169547	7.13	0.000	1.120939	1.97361
income	1.035779	.1289442	8.03	0.000	.7823917	1.289165
price	.4830921	.2077034	2.33	0.020	.0749362	.8912479
deps	.1753681	.0426421	4.11	0.000	.0915725	.2591637
ms	-.0080364	.1848487	-0.04	0.965	-.3712806	.3552078
_cons	-4.67422	1.298134	-3.60	0.000	-7.22517	-2.12327

We find that dependence is highly significant and positive. The more children you have, the more you give to charity. Is this what you expected? That should come from the literature.

When you do a fixed effects estimation and putting dummies in your model, then we have a negative relation between number of children and amount to charity.
Not really significant, but the sign already changes.

Fixed effects with individual dummy variables vs. within group estimator

```
reg charity age income price deps ms i.subject
```

Source	SS	df	MS
Model	617.680205	51	12.1113766
Residual	191.67353	418	.458549115
Total	809.353735	469	1.72570093

Number of obs = 470
F(51, 418) = 26.41
Prob > F = 0.0000
R-squared = 0.7632
Adj R-squared = 0.7343
Root MSE = .67716

charity	Coef.	Std. Err.	t	P>|t|	[95% Conf.	Interval]
age	.1022493	.2080394	0.49	0.623	-.3066845	.5111831
income	.8388101	.1112668	7.54	0.000	.6200978	1.057522
price	.3660802	.1242945	2.95	0.003	.1217601	.6104004
deps	-.0863524	.0534826	-1.61	0.107	-.1914807	.018776
ms	.1998327	.2638901	0.76	0.449	-.3188844	.7185498
subject						
2	2.067444	.4139325	4.99	0.000		

Fixed-effects (within) regression
Group variable: subject

R-sq: within = 0.1350
between = 0.0898
overall = 0.1019

corr(u_i, Xb) = 0.0243

Number of obs = 470
Number of groups = 47

Obs per group: min = 10
avg = 10.0
max = 10

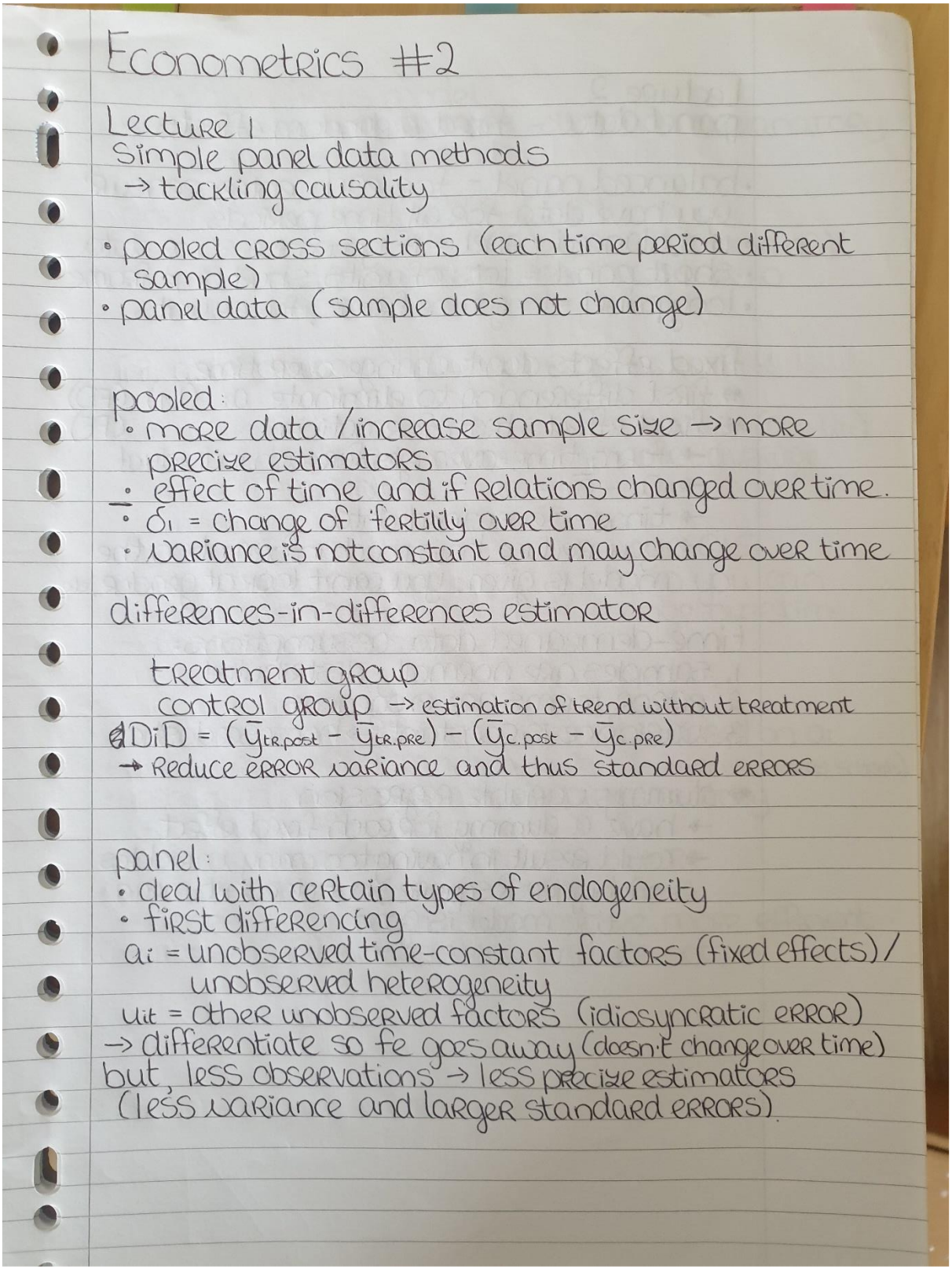
F(5,418) = 13.04
Prob > F = 0.0000

charity	Coef.	Std. Err.	t	P>|t|	[95% Conf.	Interval]
age	.1022493	.2080394	0.49	0.623	-.3066845	.5111831
income	.8388101	.1112668	7.54	0.000	.6200978	1.057522
price	.3660802	.1242945	2.95	0.003	.1217601	.6104004
deps	-.0863524	.0534826	-1.61	0.107	-.1914807	.018776
ms	.1998327	.2638901	0.76	0.449	-.3188844	.7185498
_cons	-2.089972	1.131118	-1.85	0.065	-4.313359	.1334156
sigma_u	1.0789585					
sigma_e	.67716255					
rho	.71741607	(fraction of variance due to u_i)				

The right one is the same output, same probability, etc. But not the huge set of dummies.

This is how you run it, we do that in the lab. ….., fe is for fixed effects in Stata.
Perfectly balanced panel. for each group, it's an individual. In this case we reject the null hypothesis. The covariance assumption is to be violated, so we should use fixed effects in this case.

Small summary of the econometrics part:



Econometrics #2

Lecture 1
Simple panel data methods
→ tackling causality

- pooled cross sections (each time period different sample)
- panel data (sample does not change)

pooled:
- more data / increase sample size → more precize estimators
- effect of time and if relations changed over time.
- δ_1 = change of 'fertility' over time
- variance is not constant and may change over time

differences-in-differences estimator

treatment group
control group → estimation of trend without treatment

$\hat{\delta}DiD = (\bar{y}_{TR,post} - \bar{y}_{TR,pre}) - (\bar{y}_{C,post} - \bar{y}_{C,pre})$

→ Reduce error variance and thus standard errors

panel:
- deal with certain types of endogeneity
- first differencing

a_i = unobserved time-constant factors (fixed effects) / unobserved heterogeneity
u_{it} = other unobserved factors (idiosyncratic error)

→ differentiate so fe goes away (doesn't change over time)
but, less observations → less precize estimators
(less variance and larger standard errors).

Lecture 2
panel data - fixed & random effects

- balanced panel = for each 'entrepreneur' you have data for all time periods.
- unbalanced panel = if you miss some data
- short panel = lots of units, short time frame
- long panel = long time frame, fewer units.

fixed effects don't change over time.
- first differencing to eliminate a_i (L1) (FD)
- fixed effects transformation (FE)
  - → form time-averages for each individual
  - → $a_i - \bar{a}_i = 0$
  - → time-demeaned data
  - → you reduce how much information the model is given. you can't look at gender, etc.

time-demeaned data assumptions:
1. samples are normally distributed
2. error terms are exogenous
3. variance is constant → homoscedastic

- dummy variable regression
  - → have a dummy for each fixed effect
  - → could result in having too many variables
    - → higher R square, but doesn't mean the model is good.

Random effects model
→ now a_i is uncorrelated with each explanatory variable, at all periods.

$Cov(X,Y) = E((X-E(X))(Y-E(Y)))$
→ $E(X)$ is expected value of X → the mean of X
→ if X and Y are independent, cov is zero
→ assumption that cov is zero!

Re assumption: $Cov(x_{itj}, a_i) = 0, j = 1, 2, \ldots, K$

eliminate serial correlation in the errors $(a_i + u_{it})$
→ Re subtracts a fraction of the time-average.
for all variables we have θ, between 0 and 1.
closer to 1, the closer to fe.
closer to 0, the closer to regular OLS.
→ you don't take away full part, so you can estimate factors that don't change over time.
→ θ = quasi demeaning estimator

Random effects or fixed effects? → based on a_i
- unobserved effect random → Re (sample of workers, schools)
- unobserved effect correlated with explanatory variables → fe (states, provinces)
- difference over time of gender etc. → Re
- Hausmann test → $H_0 = Cov(a_i, x_{it}) = 0$
→ under H_0: both consistent but Re more efficient
→ under H_a: fe consistent and Re not.

pooled cross section data:
- DiD method

panel data:
- FD
- FE transformation
- dummy variable regression
- RE model

DiD:

$$y = \beta_0 + \delta_0 \text{after} + \beta_1 \text{treated} + \delta_1 \text{after} \cdot \text{treated} + \text{other factors}$$

$$(\bar{y}_{1,\text{treat}} - \bar{y}_{1,\text{control}}) - (\bar{y}_{0,\text{treat}} - \bar{y}_{0,\text{control}})$$

FD:

$$y_{it} = \beta_0 + \delta_0 d87_{it} + \beta_1 unem_{it} + a_i + u_{it}$$

$$\downarrow$$

$$y_{i87} = \beta_0 + \delta_0 \cdot 1 + \beta_1 unem_{i87} + a_i + u_{i87}$$

$$y_{i82} = \beta_0 + \delta_0 \cdot 0 + \beta_1 unem_{i82} + a_i + u_{i82} \quad -$$

$$\downarrow$$

$$\Delta y_i = \delta_0 + \beta_1 \Delta unem_i + \Delta u_i$$

FE:

$$y_{it} = \beta_1 x_{it1} + \dots + \beta_k x_{itk} + a_i + u_{it}$$

$$\downarrow$$

$$(y_{it} - \bar{y}_{it}) = \beta_1 (x_{it1} - \bar{x}_{i1}) + \dots + \beta_k (x_{itk} - \bar{x}_{ik}) + (u_{it} - \bar{u}_i)$$

$\rightarrow a_i - \bar{a}_i = 0$, cause fixed effect

RE:

$$(y_{it} - \theta \bar{y}_i) = \beta_1 (x_{it1} - \theta \bar{x}_{i1}) + \dots + \beta_k (x_{itk} - \theta \bar{x}_{ik}) + (a_i - \theta \bar{a}_i + u_{it} - \theta \bar{u}_i)$$

Disclaimer

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